MONTANA REFERENCE STREAMS PROJECT:

1991 AQUATIC MACROINVERTEBRATE SURVEYS

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Summary

The Montana Department of Health and Environmental Sciences conducts annual macroinvertebrate surveys as part of its Benchmark Biology of Montana Reference Streams Program. This report presents the 1991 aquatic macroinvertebrate and habitat data for eight "least-impaired" streams. The objectives of this investigation were to:

1. determine the biological integrity, water quality and habitat condition at each sampling location,

2. calculate and evaluate selected metrics used in the 1990 survey,

3. document and evaluate metric variability
   a) among riffles within selected stream reaches,
   b) among stream reaches of selected streams,
   c) between 1990 and 1991 at selected sites.

Macroinvertebrates were collected at 21 sites and habitat condition was rated for 11 reaches in eight streams. Field, laboratory and data analysis methodology were adapted from U.S. EPA Rapid Bioassessment Protocols for habitat and macroinvertebrate assessments.

Habitat condition was classified as optimal in Armstrong Spring Creek, Seymour Creek, Boulder River, W. F. Stillwater River, S. F. Sun River and the W. F. Poplar River. Habitat was considered sub-optimal in Rock Creek and Redwater River. Compared to 1990, habitat scores increased by an average of 44% in Plains reference streams. Improved habitat condition was attributed to increased stream discharge in Plains reference streams during 1991.

Biological integrity, as measured by the RBP analysis developed from the 1990 data, was unchanged between 1990 and 1991 for all eight streams. The four Montane reference streams and the third order reach of the W. F. Poplar River were nonimpaired. Rock Creek and the second order reach of the W. F. Poplar River were considered slightly impaired while Armstrong Spring Creek and the Redwater River were classified as moderately impaired.

The minimal response in RBP assessment classifications to changed habitat condition between 1990 and 1991 suggests that water quality was an important factor limiting biological integrity in Plains reference streams. The second order reach of the W. F. Poplar River was slightly impaired by organic enrichment while high salinity appeared to limited macroinvertebrate communities in Rock Creek and the Redwater River.

Most metrics appeared sensitive to environmental change while exhibiting low variability among replicate samples and between stations with similar water and habitat quality. Riffle-to-riffle variability, as measured by the mean Coefficient of Variation, was less than 20% for 13 of 16 potential metrics. Metrics which incorporated all, or most, of the organisms in a sample were less variable than metrics based on fewer organisms. Consequently, metrics incorporating ratios of taxonomic or functional groups tended to be less variable than the individual components of the metric and metrics based on selected taxonomic or functional groups were most variable when only a few specimens of the group were present.

Among nonimpaired reaches of the Boulder River, metric variability was generally low, although several metrics were influenced by stream order. The relative abundance of Collector-gatherers, Baetidae to Ephemeroptera and Dominants in Common increased with stream order while the relative abundance of Shredders decreased with stream order. Metric variability was relatively high in the W. F. Poplar River due to between-reach differences in habitat and water quality.

Between year variability ranged from 15 to 77% for individual metrics and was much higher for Plains reference streams than for streams in other ecoregions. Hence, the inconsistences between habitat and biotic condition classifications for Plains streams appeared to be due to inadequate reference data, rather than insensitive metrics.

All ecoregion reference baselines need further testing and refinement. The Foothills and Valley and Plains reference data were developed from streams with highly variable environments and macroinvertebrate assemblages. Separate baselines need to be developed for spring and non-spring streams in the Foothills and Valleys Ecoregion and for fresh and saline Plains streams. Bioassessment criteria should be developed from assessments of streams spanning a wide range of water and habitat quality while reference communities should be developed only from nonimpaired streams. Sample replication is the simplest method of overcoming innate metric variability in slightly impaired stream reaches.

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Introduction

The Montana Department of Health and Environmental Sciences (MDHES) conducted macroinvertebrate surveys of least-impacted reference streams during 1990 and 1991 as part of its Benchmark Biology of Montana Reference Streams Program (Bahls et al. 1992). The macroinvertebrate surveys are being used to develop biological water quality criteria and provide baseline data for gauging the success of pollution control projects conducted under Section 319 of the Nonpoint Source Pollution Control Program. The 1990 macroinvertebrate survey described the composition and structure of aquatic macroinvertebrates in 36 streams and provided first generation metrics and criteria for evaluating biological integrity in montane, plains, and foothills and valleys regions (Wisseman, 1992).

This report presents the 1991 aquatic macroinvertebrate and habitat data for eight streams (Table 1). The goals of this investigation included describing riffle-to-riffle and reach-to-reach variation in metrics. To this end, samples were collected from each of three riffles on second and third order reaches of the West Fork Poplar River and from second, third and fourth order reaches of the Boulder River. Sampling was restricted to a single location on the other streams. The objectives of this investigation were to:

1. calculate and evaluate selected metrics used in the 1990 survey,

2. document and evaluate metric variability
   a) among riffles within selected stream reaches,
   b) among stream reaches of selected streams, and
   c) between 1990 and 1991 at selected sites, and

3. determine the biological integrity, water quality and habitat condition at each sampling location.

Methods

Field

Field work was conducted by Montana Water Quality Bureau (WQB) personnel. At each site, macroinvertebrates were collected using a standardized travelling kick-net technique and twelve habitat parameters were scored using a modified version of the U.S. EPA Rapid Bioassessment Protocols (RBP). Field techniques were generally consistent with those used in 1990 although the habitat assessments incorporated three parameters (canopy cover, grazing pressure and riparian zone width) not included in the 1990 habitat assessment. A more detailed description of the field work is presented in Bahls et al.

Laboratory

Laboratory and data analysis were contracted to McGuire Consulting after another consultant was unable to complete the task. Macroinvertebrates from partially sorted samples and the unsorted portions of all samples were sent to McGuire Consulting's Espanola, New Mexico laboratory. To insure sorting consistency and adherence to RPB Protocols, organisms from the partially sorted samples were combined with the unpicked portion of the original sample and each sample was reprocessed. With the exception of the Boulder River samples, a 300 organism subsample was obtained from each sample using RBP III sorting methodology (Plafkin et al. 1989 - Appendix B.2).

The subsampling procedure for the Boulder River samples was modified because the samples usually contained fewer than 300 macroinvertebrates. The macroinvertebrates in the portion of each sample sorted by the first contractor were retained as a subsample. Additional subsamples (100 organisms when available) were drawn from each sample using the RBP III random sorting technique until a total of 300 organisms, or all organisms in the sample, had been removed.

Macroinvertebrates were identified to the lowest practical taxonomic level; usually genus or species. Taxonomic levels used in metric calculations were consistent with those used in 1990 except Annelida were grouped by family rather than class. A reference collection of taxa identified during this study was returned to the MDHES.

Data Analysis

Habitat

The 1991 habitat assessments incorporated three parameters (canopy cover, grazing pressure and riparian zone width) not included in the 1990 assessment. Comparisons between years were based on the nine metrics common to both years and the cumulative habitat condition rating categories.

Macroinvertebrates

Community structure and function were characterized for each sample using a variety of potential metrics (Table 2). Descriptions, rationale and calculations of each metric can be found in Wisseman (1992) and the references listed in Table 2. The biological integrity at each site was evaluated using a slight modification of the RBP assessment developed in 1990 (Wisseman 1992). Ten of the metrics were unchanged from the pilot study; however, the EPT to Chironomidae ratio metric was modified to EPT to EPT + Chironomidae, Shannon diversity was substituted for the Brillouin index and the percent multivoline metric was dropped from the analysis. The 1990 Montane, Plains and Valley and Foothill reference data were used as baselines. The criteria used to assign metric scores (Table 3) and assess biological impairment (Table 4) were unchanged from 1990.

The Boulder River data were used to evaluate the relationship between sample size (number of organisms) and total taxa and EPT richness. Richness values were plotted against abundance for each subsample and for all combinations of subsamples within a stream reach.

Variability between 1990 and 1991 was evaluated at eight sites. Cumulative bioassessment scores were examined for variation between years and among riffles from the same stream reach. To minimize biases, the 1990 data were standardized to approximately 300 organism samples derived from percent relative abundances. Metrics were then recalculated using the 1991 biotic index tolerance values and functional group classifications. Ranges, standard deviations and coefficients of variation (expressed as a percentage of the mean) were used to describe year-to-year metric variation at eight locations and riffle-to-riffle variation within five stream reaches. A Sign test (Zar 1974) was used to test for nonrandom variation between years.

Riffle-to-riffle variability of 16 potential metrics was documented using the mean, range, standard deviation and Coefficient of Variation (C.V.). Metric variability among stream reaches within the Boulder and West Fork Poplar rivers were tested using a one-way analysis of variance. When the analysis of variance indicated a significant ($P = 0.05$) difference among stream reaches, a Newman-Kuels test (Zar 1974) was used to identify significantly different reaches.

Results and Discussion

Habitat Assessment

Overall habitat condition was rated by a combined scoring of instream, bank and riparian parameters. The 1990 habitat assessments evaluated nine parameters while the 1991 assessments incorporated 12 parameters (Table 5). Maximum possible scores were 135 in 1990 and 175 in 1991. Comparisons between years were based on the nine metrics common to both years and the cumulative habitat condition rating categories. The scoring of each metric requires a subjective evaluation which is potentially subject to variation among investigators; however, this possible source of variability was not addressed.

Armstrong Spring Creek was the only Foothills and Valleys reference stream sampled in 1991. Habitat was categorized as optimal during both years. The cumulative habitat score (nine metrics) for this site was 130 in 1990 and 120 in 1991.

All four Montane reference streams were categorized as having optimal, or near optimal (South Fork Sun River), habitat during both years. Standardized cumulative scores for each site varied by 3% or less between years. As expected for habitats in excellent condition, the additional parameters incorporated into the 1991 assessments did not alter the rating category.

Habitat condition was more variable for Plains reference streams. Among the four sites investigated, habitat ranged from optimal in the in the W. F. Poplar River (1991) to fair in the Redwater River and Rock Creek (1990). Habitat condition in the Redwater River and Rock Creek improved to sub-optimal during 1991. The downstream (third order) reach of the West Fork Poplar River improved from sub-optimal in 1990 to optimal in 1991. For the three sites evaluated during both years, cumulative scores increased by an average of 44% in 1991. The greatest change in habitat condition was in the Redwater River where the cumulative score increased 80% from 1990 to 1991. While most parameters improved in 1991 relative to 1990, increased stream flow and other metrics affected directly by increased discharge (embeddedness, pool to riffle ratio) accounted for most of the habitat improvement between years. Overall habitat ratings were not changed by the additional parameters incorporated into the 1991 assessments.

Macroinvertebrates

Macroinvertebrate identifications, enumerations, metric values for each sample and summary statistics for replicate samples are presented by location in Appendix A.

RBP III Bioassessments

Biological integrity was evaluated at each site using a slight modification of the RBP assessment developed in 1990 (Wisseman 1992). The criteria used to assign metric scores (Table 3) and assess biological impairment (Table 4) were unchanged from 1990.

FOOTHILLS AND VALLEYS ECOREGION

Compared with the Montana Foothills and Valleys reference data, Armstrong Spring Creek was classified as moderately impaired in both 1990 and 1991 (Table 6). During both years, biological impairment was indicated by low scores for EPT richness, QSI-FFG, QSI-taxa, DIC-5, % Scraper and % Collector-gatherer metrics. However, Armstrong Spring Creek is a productive trout stream with no known habitat or water quality problems and, consequently, the validity of the RBP assessment was questionable.

The Foothills and Valley reference data were a composite developed from seven spring and non-spring creeks (Bahls et al.) with highly variable macroinvertebrate faunas (Wisseman 1992). The relatively constant flow and temperature regime typical of spring creeks has a profound influence on the macroinvertebrate faunas (Hynes 1970). Rather than indicating biological impairment, the skewed composition of the benthic fauna and the limited number of mayfly, stonefly and caddisfly species found in Armstrong Spring Creek were typical of spring creeks. In this case, the reference data appeared to be inadequate to provide an accurate assessment of biological integrity. The appropriateness of this reference data for evaluating streams not influenced by springs has also been questioned (McGuire 1992). Clearly, separate baselines need to be developed for spring and non-spring streams within the Foothills and Valleys ecoregion.

MONTANE ECOREGION

Biological integrity appeared to be nonimpaired in the four montane reference streams sampled in 1991. This statement was made with qualification since assessments of Seymour Creek, W. F. Stillwater, and S. F. Sun rivers were based on single samples (Table 7). The importance of replicate sampling was underscored by one of nine samples from the Boulder River falling in the slightly-impaired category (Table 8). Additionally, the ability of the Montane reference data to document biological impairment has not been rigorously tested.

PLAINS ECOREGION

During 1991, biological impairment was indicated in three of the four stream reaches examined in the Plains ecoregion (Table 9). Despite improved habitat conditions during 1991 (Table 5), biological integrity was unchanged in the three stream reaches sampled in 1990 and 1991. Water quality appeared to be an important factor limiting biological communities in Plains reference streams.

In the upstream reach of the W. F. Poplar River (2nd order), biological integrity was slightly impaired while habitat was rated as optimal. Comparability to the reference community averaged 64% due, primarily, to low scores for the EPT richness, EPT relative abundance, and EPT/EPTC metrics (Table 9). The limited EPT fauna, biotic index values of 7.2, and high relative abundances of chironomid genera tolerant of low dissolved oxygen concentrations were indicative of organic pollution. Organic loads in this reach may have been augmented by autotrophic production in the numerous backwaters and ponded areas (described in field notes) in this stream reach.

The third order reach of the W. F. Poplar River had the highest biological integrity among the four Plains Reference sites and was considered nonimpaired. Relative to the upstream reach, improved water quality was indicated by decreased chironomid relative abundance, a lower biotic index, increased EPT richness and increased EPT relative abundance.

Rock Creek and the Redwater River were characterized by single samples in 1990 and 1991. In both streams, increased discharge during 1991 resulted in improved habitat condition; however, the biological integrity of each stream was unchanged between years. Rock Creek was classified as slightly impaired while the Redwater River was moderately impaired. Community composition in the Redwater River changed dramatically between years. Species replacement was nearly complete with only three taxa common to samples from both years. The RBP's lack of response to changes in community composition suggests that the bioassessments were measuring impairment due to poor water quality and were insensitive to improving habitat condition. High salinities in these streams (Bahls et al.) may limit benthic faunas to tolerant organisms.

Effect of sample size on metric values

Montana's biocriteria are being developed on the basis of 300 organism standards. Unfortunately, seven of nine samples from the Boulder River contained substantially less than 300 macroinvertebrates and, consequently, taxa richness (Figure 1) and EPT richness (Figure 2) were underestimated relative to the 300 organism standard. The two samples that contained approximately 300 organisms had taxa richness values of 26 and 27 and EPT richness values of 18 and 19. The number of organisms in the other seven samples ranged from 95 to 259 organisms. The mean number of organisms, taxa richness and EPT richness for these seven samples were, respectively, 182, 22.1 and 16. The relation between richness and abundance was obvious when the values for each Boulder River subsample and for all combinations of subsamples within a stream reach were plotted (Figures 3 and 4).

A standard subsample size is critical for reliable RBP analyses because taxa richness, EPT richness and, to a lesser degree, the Community Loss Index are influenced by the number of organisms comprising a sample. Richness values for Boulder River samples were clearly biased by variable sample size. An ANOVA of EPT richness indicated significant differences among stream reaches when the variable sample size was used ($P = 0.05$), but no significant differences ($P = 0.49$) when sample size was standardized at approximately 100 organisms.

Metric variability within stream reaches

Riffle-to-riffle variability was evaluated within three reaches of the Boulder and two reaches of W. F. Poplar rivers. With the exception of the third order reach of the Boulder River, bioassessment scores were similar for all three samples within each of the five stream reaches (Tables 8 and 9). Within reach bioassessment scores had a mean coefficient of variation (C.V.) of five percent. The highest C.V. (11%) was for the third order reach of the Boulder River. Within this reach, one sample was classified as slightly impaired while two samples were nonimpaired.

Data from both streams indicated that metric values were less variable in unimpaired stream reaches than in stressed reaches. The third order reach of the Boulder River (Table 10) and the second order reach of the W. F. Poplar River (Table 11) had substantially higher C.V. values than did adjacent, nonimpaired stream reaches . In each of these reaches, at least one sample was classified as slightly impaired. While a single sample usually provides a reliable assessment in nonimpaired environments, additional sample replication may be needed for accurate assessments of slightly impaired environments.

The mean C.V. for the five stream reaches was used as a measure of individual metric variability. Riffle-to-riffle variability was low for most metrics although one sample from the third order reach of the Boulder River increased variability within this reach and for the overall study (Table 10). For individual metrics, the mean C.V. ranged from five to 54%; however, the mean C.V. was less than 20% for 13 of 18 potential metrics. Variability averaged less than 10% for the QSI-taxa, Shannon diversity and QSI-FFG metrics. Mean coefficients of variation exceeded 25% for the % Chironomidae, % Filterers, % Collector-gathers and Baetidae to Ephemeroptera metrics.

Low riffle-to-riffle variability is desirable for metrics used to assess biotic condition, particularly when sampling effort is limited, and innate variability should be factored into scoring criteria. Metrics which incorporated all, or most of the organisms in a sample, were less variable than metrics based on fewer organisms. Metrics based on selected taxonomic or functional groups were most variable when only a few specimens of the group were present. Metrics that incorporated ratios of taxonomic or functional groups tended to be less variable than the individual components of the metric. For example, the EPT to EPTC ratio had a lower C.V. than EPT relative abundance or Chironomidae relative abundance.

Metric variability among stream reaches

Reach-to-reach variability was also examined in the Boulder (Table 10) and West Fork Poplar (Table 11) rivers. Despite one contraindicating sample, biological integrity was generally nonimpaired in the Boulder River and there were few distinct differences among metric values in the three stream reaches. For the 12 metrics used in the RBP analysis, an ANOVA indicated significant differences among reaches for the % Collector-gatherer, Baetidae to Ephemeroptera ratio and Dominants in Common metrics. Values for each of these metrics increased with stream order. There were also significant inverse relationships between stream order and the relative abundances of Plecoptera and shredders.

Differences in water quality and habitat condition resulted in high metric variability between reaches of the W. F. Poplar River and most metrics values were significantly different ($P = 0.5$) between reaches. The EPT richness, biotic index, % EPT, % Collector-gathers, EPT/EPTC and % Chironomidae metrics indicated lower biological integrity in the upstream reach while taxa richness, Shannon diversity, QSI-taxa and Community Loss Index indicated higher biological integrity in this reach. Values for the % dominant taxon, QSI-FFG and Dominants in Common were not significantly different between reaches. Agreement between statistical significance (Table 11) and metric scores (Table 9) were generally good, although a few inconsistences indicated that metrics, scoring criteria and reference values could be refined for this ecoregion. In particular, scoring criteria and reference values for the biotic index, taxa richness and Community Loss Index should be revised.

Metric variability between years

Initially, metric values for 1990 were taken directly from Wisseman (1992) and comparisons between the two data sets revealed biases in several metrics due to differences in laboratory processing and metric calculation (McGuire July 1992 -draft report). Variability between 1990 and 1991 was evaluated at eight sites. To minimize biases, the 1990 data were standardized to approximately 300 organism samples derived from percent relative abundances. Metrics were then recalculated using the 1991 biotic index tolerance values (Appendix B) and functional group classifications.

The recalculated 1990 data were used as the reference for calculating metrics that incorporated direct comparisons to a reference (Table 12). Values for Montane references streams were quite high, indicating little variation between years. In contrast, macroinvertebrate assemblages in Plains reference streams were markedly different in 1990 than in 1991.

The mean C. V. as a measure of overall variability for additional metrics. Between-year variability ranged from nine to 73% for individual metrics (Table 13) and was relatively low (<25%) for Shannon diversity, CTQ a, Biotic index, Taxa richness, EPT richness, and % dominant. The % Chironomidae, Baetidae to Ephemeroptera, and all functional feeding group metrics were more variable. Despite the attempt to standardize sample size, taxa richness remained biased toward higher values in 1990 than in 1991.

Between-year metric variability was higher for Plains streams than for Montane streams (Table 13). For all metrics, the mean C. V. was 25% for Montane streams and 49% for Plains streams. Between-year differences were greatest in the Redwater River where metrics had an average C.V. of 68%. Increased stream flows during 1991 resulted in substantially improved habitat conditions in Plains reference streams (Table 5). Thus, changed environmental conditions were probably an important source of between-year variation in Plains reference streams. Although metric values for Plains streams changed markedly between years, biotic integrity classifications did not. This appeared to be a consequence of the assessment criteria and baseline being developed during the 1990 drought. The RBP reference and scoring criteria should be refined to reflect the major changes in community composition and structure between years.

Conclusions

Environmental conditions

1. During 1991, habitat condition was classified as optimal in Armstrong Spring Creek, Seymour Creek, Boulder River , W. F. Stillwater River, S. F. Sun River and the second order reach of the W. F. Poplar River. Habitat was considered sub-optimal in Rock Creek, Redwater River and near optimal in the third order reach of the W. F. Poplar River.

2. Increased stream discharge improved aquatic habitat in Plains reference streams during 1991. Compared to 1990 scores, habitat assessments increased by an average of 44%. Habitat classifications improved from fair to sub-optimal in Rock Creek and the Redwater River.

3. Biological integrity, as measured by the RBP analysis developed from the 1990 data, was unchanged between 1990 and 1991 for all eight streams. The four Montane reference streams and the third order reach of the W. F. Poplar River were nonimpaired. Rock Creek and the second order reach of the W. F. Poplar River were considered slightly impaired while Armstrong Spring Creek and the Redwater River were classified as moderately impaired.

4. Water quality appeared to be an important factor limiting biological integrity in Plains reference streams. The second order reach of the W. F. Poplar River was slightly impaired by organic enrichment while high salinity appeared to limited macroinvertebrate communities in Rock Creek and the Redwater River.

Metric variability

5. Most metrics appeared sensitive to environmental change while exhibiting low variability among replicate samples and between stations with similar water and habitat quality.

6. Riffle-to-riffle variability was generally low; the mean Coefficient of Variation was less than 20% for 13 of 18 potential metrics.

7. Metric variability was low among nonimpaired reaches of the Boulder River, although several metrics were influenced by stream order. The relative abundance of Collector-gatherers, Baetidae to Ephemeroptera and Dominants in Common increased with stream order while the relative abundance of Shredders decreased with stream order.

8. Metric variability was high in the W. F. Poplar River due to between-reach differences in habitat and water quality.

9. Between-year variability ranged from 15 to 77% for individual metrics and from nine to 73% for individual sites. Changed habitat condition at some sites increased year-to-year variability.

10. Metrics which incorporated all, or most of the organisms in a sample, were less variable than metrics based on fewer organisms.

11. Metrics based on selected taxonomic or functional groups were most variable when only a few specimens of the group were present. Metrics that incorporated ratios of taxonomic or functional groups tended to be less variable than the individual components of the metric.

12. Metrics exhibiting high variability were those with relatively broad scoring criteria.

13. Sample replication is the simplest method of overcoming innate metric variability in slightly impaired stream reaches.

Ecoregion references

14. The Foothills and Valley reference data was developed from streams with highly variable environments and macroinvertebrate assemblages. Separate baselines need to be developed for spring and non-spring streams in this ecoregion.

15. Streams in the Plains ecoregion have a wide range of water quality and macroinvertebrate assemblages. Separate baselines should be developed for fresh- and saline streams.

16. All ecoregion reference baselines need further testing and refinement. Bioassessment criteria should be developed from assessments of streams spanning a wide range of water and habitat quality. Reference communities should be developed from nonimpaired streams.

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Table 1. Montana reference streams sampled in 1991.

Ecoregion Stream	Tributary of	General location	Sampling location	Water use class
Northern Rockies (#15)				
Seymour Cr.	Big Hole R.	Anaconda Range	T3N R13W Sec 9	A-1
S. F. Sun R.	Sun R.	Lewis & Clark Co.	T20N R10W Sec 8	A-1/B-1
Middle Rockies (#17)				
W. F. Stillwater R.	Stillwater R.	Sweet Grass Co.	T5S R14E Sec 14	A-1
Boulder R. (2nd order)	Yellowstone R.	Sweet Grass Co.		A-1
Boulder R. (3rd order)	Yellowstone R.	Sweet Grass Co.	T7S R12E Sec 5	A-1
Boulder R. (4th order)	Yellowstone R.	Sweet Grass Co.	T6S R12E Sec 28	A-1
Northern Montana Glaciated Plains (#41)				
Rock Cr. nr. Hinsdale	Milk R.	Valley Co.	T36N R3E Sec 8	B-3
Northwestern Great Plains (#43)				
W. F. Poplar R. (2nd order)	Poplar R.	Daniels Co.	T37N R41E Sec 9	B-2
W. F. Poplar R. (3rd order)	Poplar R.	Daniels Co.	T32N R48E Sec 2	B-2
Redwater R.	Missouri R.	McCone Co.	T25n R50E Sec 23	C-3
Montana Valley & Foothill Praires (#16)				
Armstrong Spring Cr.	Yellowstone R.	Park Co.	T3S R9E Sec 26	B-1

Table 2. Metrics used to characterize aquatic macroinvertebrate assemblages in Montana reference streams during 1991.

Metric	Reference
Taxa richness	Plafkin et al. (1989)
EPT richness	Plafkin et al. (1989)
Biotic index	Plafkin et al. (1989), Hilsenhoff (1989)
CTQa (%RA)	Winget and Mangum (1979)
Shannon diversity	Weber (1973)
% dominant taxon	Plafkin et al. (1989)
Dominants in common (DIC-5)	Shackleford (1988)
Qualitative Similarity Index (QSI-taxa)	Shackleford (1988)
Community Loss Index (CLI)	Courtemanch & Davies (1987)
% Collector - Gatherers	
% Shredders	Plafkin et al. (1989)
% Predators	
% Scrapers	
% Filterers	
Scrapers/(Scrapers + Filterers)	Plafkin et al. (1989)
Scrapers/(Scapers + C-Gatherers)	
QSI- FFG	Shackleford (1988)
% Chironomidae	
% Diptera	
% Coleoptera	
% Ephemeroptera	
% Plecoptera	
% Trichoptera	
% misc. Insecta	
% Annelida	
% Crustacea	
% Mollusca	
% misc. non-insects	
Baetidae/Ephemeroptera	
Hydropsychinae/Trichoptera	
% EPT	
EPT/EPTC	Plafkin et al. (1989)

Table 3. Criteria for assigning scores to metrics based on percent comparability to reference values (adapted from Wisseman 1992).

	Scoring Criteria				
metric	6	4	2	0	*
Taxa richness	>80%	60-80%	40-60%	<40%	a
EPT richness	>90%	80-90%	70-80%	<70%	a
Biotic index	>85%	70-85%	50-70%	<50%	b
Shannon diversity	>90%	80-90%	70-80%	<70%	a
% Collector-gather	>80%	60-80%	40-60%	<40%	b
% dominant taxon	<30%	30-40%	40-50%	>50%	c
QSI-taxa	>0.4	0.3-0.4	0.2-0.3	<0.2	d
QSI-FFG	>0.75	0.65-0.75	0.55-0.65	<0.55	d
DIC-5	3 - 5	2	1	0	d
Community Loss Index	<0.6	0.6-1.5	1.5-4.0	>4.0	d
% Chironomidae	>75%	50-75%	25-50%	<25%	b
% Scraper	>80%	60-80%	40-60%	<40%	a
% EPT	>80%	60-80%	40-60%	<40%	a
Baetidae/Ephemeroptera	>75%	50-75%	25-50%	<25%	b

* a = score is ratio of study site to reference site X 100.
* b = score is ratio of reference site to study site X 100.
* c = score is based on actual values, not % comparision to reference.
* d = comparison to reference site is incorporated in this index.

Table 4. Criteria for the assessment of biologically significant environmental degradation (from Plafkin et al 1989).

% comp. to reference	Classification
>83%	nonimpaired
54-79%	slightly impaired
21-50%	moderately impaired
<17%	severely impaired

Table 5. Stream and riparian habitat assessments for Montana reference streams during 1990 (nine parameters) and 1991 (12 parameters).

Habitat metric:	1	2	3	4	5	6	7	8	9	10	11	12	Total	StandardizedTot
Maximum score:	20	20	20	20	15	15	15	10	10	10	10	10	175	135
Boulder R.-2nd														
1991	17	18	20	17	14	12	15	5	10	10	10	10	158	121
Boulder R.-3rd														
1991	20	19	20	18	12	11	14	8	9	10	10	10	161	123
Boulder R.-4th														
1991	20	20	19	16	14	11	12	8	10	10	10	10	160	124
W.F. Stillwater R.														
1990	20	13	18	-	11	11	15	8	10	-	7	-	113	113
1991	20	18	20	16	9	10	15	7	9	10	9	9	152	117
S.F. Sun R.														
1990	20	20	16	-	10	11	11	8	8	-	5	-	109	109
1991	19	11	16	16	10	12	15	7	9	10	7	10	142	106
Seymour Cr.														
1990	20	18	16	-	11	11	10	9	10	-	10	-	115	115
1991	20	16	15	18	11	9	13	9	10	10	10	10	151	113
W. F. Poplar R. -2nd														
1991	19	19	8	16	14	15	14	8	9	8	5	10	145	111
W.F. Poplar R.-3rd														
1990	17	15	10	-	13	8	9	6	8	-	4	-	90	90
1991	18	18	18	5	12	12	11	5	9	5	5	10	128	108
Redwater R.														
1990	17	3	1	-	8	8	6	3	6	-	4	-	56	56
1991	18	12	15	2	13	10	15	5	8	8	5	7	118	101
Rock Cr.														
1990	15	2	1	-	12	8	8	8	9	-	5	-	68	68
1991	18	15	2	2	15	10	7	8	8	9	7	3	104	90
Armstrong Spring Cr.														
1990	20	18	20	-	15	15	14	9	10	-	9	-	130	130
1991	18	16	16	-	15	15	12	8	10	-	10	-	120	120

1 Bottom substrate	2 Embeddedness	3 Flow	4 Canopy cover
5 Channel morphology	6 Substrate stability	7 Pool/riffle ratio	8 Bank stability
9 Bank cover stability	10 Grazing pressure	11 Streamside cover	12 Riparian zone width

RATING (9 parameters): OPTIMAL 135-111, SUB-OPTIMAL 102-75, FAIR 66-39, POOR 30-0
RATING (12 parameters): OPTIMAL 175-145, SUB-OPTIMAL 133-98, FAIR 86-51, POOR 39-0

TABLE 6. The values, percentages of reference value and bioassessment scores of selected metrics characterizing the biological integrity in Armstrong Spring Creek during 1990 and 1991.

Metric	Reference*	1990*	1991
Calculated value			
Taxa richness	34	24	19
EPT richness	16	7	3
Biotic index	3.8	5.7	5.7
Shannon diversity	3.4	3.3	3.3
Baetidae/Ephemeroptera	0.45	0.98	0.85
% RA Scrapers	24	0.3	10
% RA Collector-gatherers	33	66	84
% RA dominant taxon	35	19	22
QSI-taxa	0.3	0.24	0.18
QSI-FFG	0.6	0.53	0.46
DIC-5	1.6	1	0
Community Loss Index	0.5	0.9	1.2
Percent of Reference			
Taxa richness		71	56
EPT richness		44	19
Biotic index		66	66
Shannon diversity		96	96
Baetidae/Ephemeroptera		46	53
% RA Scrapers		1	42
% RA Collector-gatherers		53	42
Score			
Taxa richness	6	4	2
EPT richness	6	0	0
Biotic index	6	2	2
Shannon diversity	6	6	6
Baetidae/Ephemeroptera	6	2	4
% RA Scrapers	6	0	2
% RA Collector-gatherers	6	2	2
% RA dominant taxon	4	6	6
QSI-taxa	2	2	0
QSI-FFG	4	0	0
DIC-5	4	2	0
Community Loss Index	6	4	4
Biological Condition			
Score	62	30	28
% of Reference	100	48	45
Condition	NON	MOD	MOD

Categories: NONIMPAIRED, SLIGHTLY impaired, MODERATELY impaired, SEVERELY impaired.

* from Wisseman 1992.

TABLE 7. The values, percentages of reference value and bioassessment scores of selected metrics characterizing the biological integrity in three Montane references streams during 1991.

Metric	Reference*	W. F. Stillwater R.	S. F. Sun R.	Seymour Cr.
Calculated value				
Taxa richness	34	23	32	37
EPT richness	22	18	23	29
Biotic index	2.5	1.0	1.2	1.5
Shannon diversity	3.4	2.8	3.5	4.5
Baetidae/Ephemeroptera	0.20	0.13	0.10	0.10
% RA Scrapers	36	71	74	41
% RA Collector-gatherers	36	22	12	23
% RA dominant taxon	29	36	24	15
QSI-taxa	0.46	0.34	0.47	0.42
QSI-FFG	0.85	0.65	0.61	0.76
DIC-5	2.40	4	5	3
Community Loss Index	0.37	0.8	0.5	0.4
Percent of Reference				
Taxa richness		68	94	109
EPT richness		82	105	132
Biotic index		258	208	164
Shannon diversity		83	102	133
Baetidae/Ephemeroptera		154	200	200
% RA Scrapers		197	206	114
% RA Collector-gatherers		164	300	157
Score				
Taxa richness	6	4	6	6
EPT richness	6	4	6	6
Biotic index	6	6	6	6
Shannon diversity	6	4	6	6
Baetidae/Ephemeroptera	6	6	6	6
% RA Scrapers	6	6	6	6
% RA Collector-gatherers	6	6	6	6
% RA dominant taxon	6	4	6	6
QSI-taxa	4	4	6	6
QSI-FFG	4	5	4	6
DIC-5	4	6	6	6
Community Loss Index	6	4	4	4
Biological Condition				
Score	66	59	68	70
% of Reference	100	89	103	106
Condition	NON	NON	NON	NON

Categories: NONIMPAIRED, SLIGHTLY impaired, MODERATELY impaired, SEVERELY impaired.

* from Wisseman 1992.

TABLE 8. The values, percentages of reference value and bioassessment scores of selected metrics characterizing the biological integrity in three reaches of the Boulder River on August 22, 1991 (three samples per reach).

		Boulder (2nd order)			Boulder (3rd order)			Boulder (4th order)		
Metric	Reference*	riffle 1	riffle 2	riffle 3	riffle 1	riffle 2	riffle 3	riffle 1	riffle 2	Riffle 3
Calculated value										
Taxa richness	34	27	26	21	23	17	24	21	22	27
EPT richness	22	18	19	16	15	14	16	16	17	18
Biotic index	2.5	1.0	1.0	1.1	1.9	0.8	1.2	1.4	1.8	2.1
Shannon diversity	3.4	3.9	3.7	3.5	4.0	2.9	3.7	3.3	3.4	3.2
Baetidae/Ephemeroptera	0.20	0.10	0.13	0.31	0.29	0.13	0.16	0.35	0.41	0.42
% RA Scrapers	36	40	42	40	38	69	49	49	46	47
% RA Collector-gatherers	36	11	7	19	28	12	13	28	36	43
% RA dominant taxon	29	17	20	18	15	37	18	25	32	33
QSI-taxa	0.38	0.39	0.38	0.37	0.44	0.38	0.47	0.41	0.42	0.42
QSI-FFG	0.73	0.68	0.64	0.76	0.85	0.63	0.68	0.78	0.88	0.81
DIC-5	2	2	2	3	3	4	4	3	3	3
Community Loss Index	0.58	0.6	0.6	0.9	0.7	1.3	0.8	0.8	0.8	0.6
Percent of Reference										
Taxa richness		79	76	62	68	50	71	62	65	79
EPT richness		82	86	73	68	64	73	73	77	82
Biotic index		245	263	238	130	321	216	179	142	118
Shannon diversity		116	108	101	116	84	109	96	101	93
Baetidae/Ephemeroptera		200	154	65	69	154	125	57	49	48
% RA Scrapers		111	117	111	106	192	136	136	128	131
% RA Collector-gatherers		327	514	189	129	300	277	129	100	84
Score										
Taxa richness	6	4	4	4	4	2	4	4	4	4
EPT richness	6	4	4	4	0	0	2	2	2	4
Biotic index	6	6	6	6	6	6	6	6	6	6
Shannon diversity	6	6	6	6	6	4	6	6	6	6
Baetidae/Ephemeroptera	6	6	6	4	4	6	6	4	2	2
% RA Scrapers	6	6	6	6	6	6	6	6	6	6
% RA Collector-gatherers	6	6	6	6	6	6	6	6	6	6
% RA dominant taxon	6	6	6	6	6	4	6	6	4	4
QSI-taxa	4	4	4	4	6	4	6	6	6	6
QSI-FFG	4	4	2	6	6	2	4	6	6	6
DIC-5	4	4	4	6	6	6	6	6	6	6
Community Loss Index	6	5	5	4	4	4	4	4	4	6
Biological Condition										
Score	66	61	59	60	60	50	62	62	58	62
% of Reference	100	92	89	91	91	76	94	94	88	94
Condition	NON	NON	NON	NON	NON	SLI	NON	NON	NON	NON

Categories: NONIMPAIRED, SLIGHTLY impaired, MODERATELY impaired, SEVERELY impaired.

* from Wisseman 1992.

TABLE 9. The values, percentages of reference value and bioassessment scores of selected metrics characterizing the biological integrity in four Plains reference streams during 1991.

		W. F. Poplar (2nd order)			W. F. Poplar (3rd order)			Redwater	Rock
Metric	Reference*	riffle 1	riffle 2	riffle 3	riffle 1	riffle 2	riffle 3	River	Creek
Calculated value									
Taxa richness	29	21	22	22	17	19	17	13	23
EPT richness	6	4	4	7	10	10	9	3	3
Biotic index	7.0	7.2	7.2	7.2	6.0	5.9	6.1	5.2	6.0
Shannon diversity	3.3	3.1	3.1	3.0	2.8	2.7	2.7	1.5	2.7
% EPT	20	2	1	4	35	32	33	85	13
EPT/EPTC	0.59	0.09	0.08	0.17	0.96	0.96	0.95	0.87	0.16
% RA Collector-gatherers	48	65	62	70	44	44	41	14	72
% RA dominant taxon	35	37	34	41	34	35	35	77	50
QSI-taxa	0.34	0.35	0.33	0.32	0.30	0.28	0.29	0.06	0.16
QSI-FFG	0.68	0.73	0.66	0.76	0.72	0.70	0.68	0.36	0.68
DIC-5	1.50	2	1	2	2	2	2	0	1
Community Loss Index	0.66	0.8	0.7	0.9	1.1	1.0	1.1	1.5	0.7
Percent of Reference									
Taxa richness		72	76	76	59	66	59	45	79
EPT richness		67	67	117	167	167	150	50	50
Biotic index		97	97	97	117	118	116	134	116
Shannon diversity		93	95	89	86	82	81	44	82
% EPT		10	5	20	172	157	162	417	64
EPT/EPTC		15	14	29	163	163	161	147	27
% RA Collector-gatherers		73	77	68	108	108	116	341	66
Score									
Taxa richness	6	4	4	4	2	4	2	2	4
EPT richness	6	0	0	6	6	6	6	0	0
Biotic index	6	6	6	6	6	6	6	6	6
Shannon diversity	6	6	6	4	4	4	4	0	4
% EPT	6	0	0	0	6	6	6	6	4
EPT/EPTC	6	0	0	0	6	6	6	6	2
% RA Collector-gatherers	6	4	4	4	6	6	6	6	4
% RA dominant taxon	6	4	4	2	4	4	4	0	1
QSI-taxa	4	4	4	4	3	2	2	0	0
QSI-FFG	4	4	4	6	4	4	4	0	4
DIC-5	4	4	2	4	4	4	4	0	2
Community Loss Index	4	4	4	4	4	4	4	2	4
Biological Condition									
Score	64	40	38	44	55	56	54	28	35
% of Reference	100	63	59	69	86	88	84	44	55
Condition	NON	SLI	SLI	SLI	NON	NON	NON	MOD	SLI

Categories: NONIMPAIRED, SLIGHTLY impaired, MODERATELY impaired, SEVERELY impaired.

* from Wisseman 1992.

Table 10. The mean, range, standard deviation and coefficient of variation of selected metrics within stream reaches and One-Way ANOVA of between reach variability in the Boulder River on August 22, 1991 (three samples per reach).

Metric	Stream Reach				ANOVA	Significant***
	2nd order	3rd order	4th order	all	P value	reach differences
Taxa richness*					0.96	none
mean	20	19	19	19.3		
min.	17	16	15	15		
max.	24	22	22	24		
S.D.	3.6	3	3.6	3		
C.V.	18%	16%	19%	16%		
EPT richness*					0.49	none
mean	15.3	13.7	14.3	14.4		
min.	13	13	12	12		
max.	17	14	17	17		
S.D.	2.1	0.6	2.5	1.8		
C.V.	14%	4%	18%	13%		
Biotic index					0.14	none
mean	1.01	1.28	1.76	1.35		
min.	0.95	0.78	1.4	0.78		
max.	1.05	1.92	2.11	2.11		
S.D.	0.05	0.58	0.36	0.5		
C.V.	5%	45%	20%	35%		
CTQa (%RA)					0.16	none
mean	31	35	43	36		
min.	30	28	38	28		
max.	34	46	47	47		
S.D.	2	10	5	8		
C.V.	7%	30%	11%	21%		
S. diversity					0.73	none
mean	3.68	3.51	3.28	3.49		
min.	3.45	2.86	3.15	2.86		
max.	3.93	3.96	3.44	3.96		
S.D.	0.24	0.58	0.15	0.37		
C.V.	7%	16%	5%	10%		
% Dominant					0.54	none
mean	18	23	30	23.9		
min.	17	15	25	15		
max.	20	37	33	37		
S.D.	1	12	4	8.2		
C.V.	7%	52%	13%	34%		

Table 10. Continued.

Metric	Stream Reach				ANOVA	Significant**
	2nd order	3rd order	4th order	all	P value	reach differences
QSI-taxa					0.15	none
mean	0.38	0.43	0.42	0.41		
min.	0.37	0.38	0.41	0.37		
max.	0.39	0.47	0.42	0.47		
S.D.	0.01	0.05	0.01	0.03		
C.V.	3%	11%	1%	8%		
% C-gatherers					0.02	1 and 2 < 4
mean	12	18	36	21.9		
min.	7	12	28	7		
max.	19	28	43	43		
S.D.	6	9	7	12.5		
C.V.	48%	51%	20%	57%		
% Scrapers					0.37	none
mean	41	52	47	47		
min.	40	38	46	38		
max.	42	69	49	69		
S.D.	1	16	1	9		
C.V.	3%	30%	3%	20%		
% Shredders					0.001	2 > 3 and 4
mean	25	7	3	11.7		
min.	22	4	2	2		
max.	28	11	4	28		
S.D.	3	3	1	10.5		
C.V.	12%	43%	37%	90%		
% Filterers					0.21	none
mean	6	4	3	4.1		
min.	4	1	1	1		
max.	8	6	4	8		
S.D.	2	3	1	2.3		
C.V.	35%	65%	48%	56%		
QSI-FFG					0.20	none
mean	0.69	0.72	0.82	0.74		
min.	0.64	0.63	0.78	0.63		
max.	0.76	0.85	0.88	0.88		
S.D.	0.061	0.12	0.05	0.09		
C.V.	9%	16%	6%	12%		

Table 10. Concluded.

Metric	Stream Reach				ANOVA	Significant**
	2nd order	3rd order	4th order	all	P value	reach differences
% Chironomidae					0.63	none
mean	3	8	5	6		
min.	2	1	3	1		
max.	6	18	10	18		
S.D.	3	9	4	5		
C.V.	74%	106%	70%	95%		
EPT/EPTC					0.68	none
mean	0.96	0.92	0.95	0.94		
min.	0.93	0.82	0.9	0.82		
max.	0.98	0.99	0.97	0.99		
S.D.	0.03	0.09	0.04	0.05		
C.V.	3%	10%	4%	6%		
DIC-5					0.04	2 < 3
mean	2.3	3.7	3.0	3.0		
min.	2	3	3	2		
max.	3	4	3	4		
S.D.	0.6	0.6	0.0	0.7		
C.V.	25%	16%	0%	24%		
Mean C.V.						
all metrics	18%	34%	18%	33%		

* Taxa and EPT richness based on ~100 organism subsamples.
** Newman-Kuels test (P = 0.05) for sighificant differences among stream reaches.

Table 11. The mean, range, standard deviation and coefficient of variation of selected metrics within and and One-Way ANOVAs of between reach variability in the West For Poplar River on September 7, 1991 (three samples per reach).

Metric	Stream Reach			ANOVA	Significant
	2nd order	3rd order	both	P value	reach differences
Taxa richness				0.01	2 > 3
mean	21.7	17.7	19.7		
min.	21	17	17		
max.	22	19	22		
S.D.	0.6	1.2	2.3		
C.V.	3%	7%	12%		
EPT richness				0.01	2 < 3
mean	5	9.7	7.3		
min.	4	9	4		
max.	7	10	10		
S.D.	1.7	0.6	2.8		
C.V.	35%	6%	38%		
Biotic index				0.00	2 > 3
mean	7.2	5.99	6.6		
min.	7.19	5.94	5.94		
max.	7.24	6.05	7.24		
S.D.	0.03	0.06	0.67		
C.V.	0%	1%	10%		
CTQa (%RA)				0.00	2 > 3
mean	102	89	96		
min.	101	88	88		
max.	103	89	103		
S.D.	1	1	7.5		
C.V.	3%	1%	8%		
S. diversity				0.01	2 > 3
mean	3.04	2.75	2.9		
min.	2.95	2.68	2.68		
max.	3.12	2.84	3.12		
S.D.	0.09	0.08	0.18		
C.V.	3%	3%	6%		
% Dominant				0.24	2 = 3
mean	37	35	36		
min.	34	34	[illegible]		
max.	41	35	41		
S.D.	3	1	2.7		
C.V.	9%	2%	7%		

Table 11. Continued.

Metric	Stream Reach			ANOVA	Significant
	2nd order	3rd order	both	P value	reach differences
QSI-taxa				0.02	2 > 3
mean	0.33	0.29	0.31		
min.	0.32	0.28	0.28		
max.	0.35	0.30	0.35		
S.D.	0.02	0.01	0.03		
C.V.	5%	3%	8%		
% C-gatherers				0.84	2 = 3
mean	69	42	56		
min.	65	41	41		
max.	72	44	72		
S.D.	4	1.5	15		
C.V.	5%	4%	27%		
% Scrapers				0.12	2 = 3
mean	16	6	6		
min.	7	6	6		
max.	26	6	6		
S.D.	9	0	0		
C.V.	57%	3%	3%		
% Filterers				0.00	2 < 3
mean	9	51	30		
min.	6	49	6		
max.	12	52	52		
S.D.	3	1	22.7		
C.V.	30%	3%	76%		
QSI-FFG				0.63	2 = 3
mean	0.72	0.70	0.71		
min.	0.66	0.68	0.66		
max.	0.76	0.72	0.73		
S.D.	0.05	0.02	0.04		
C.V.	7%	3%	5%		
DIC-5				0.29	2 = 3
mean	1.7	2.0	1.8		
min.	1	2	2		
max.	2	2	2		
S.D.	0.6	0.0	0.4		
C.V.	34%	0%	22%		

Table 11. Concluded.

Metric	Stream Reach			ANOVA	Significant
	2nd order	3rd order	both	P value	reach differences
% Chironomidae				0.00	2 > 3
mean	19	1	10		
min.	18	1	1		
max.	20	2	20		
S.D.	1	0	9.7		
C.V.	3%	17%	95%		
% EPT				0.00	2 < 3
mean	2	33	18		
min.	1	32	1		
max.	4	35	35		
S.D.	2	2	17		
C.V.	66%	5%	96%		
EPT/EPTC				0.00	2 < 3
mean	0.11	0.96	0.54		
min.	0.08	0.95	0.08		
max.	0.17	0.96	0.96		
S.D.	0.05	0.01	0.46		
C.V.	45%	1%	87%		
Mean C.V.					
all metrics	20%	4%	33%		

Table 12. The Community Loss Index, Quantitative Similarity Index-taxa, Quantitative Similarity Index-functional and Dominants-in-Common metric values at eight Montana reference sites: 1990 vs 1991 (sample size standardized at 300 organisms where possible).

Metric	STREAM								
	Bould	WF St	SF Su	Seym	WF Pop	Redw	Rock	Armst	Mean
Community Loss Index									
90 vs 91	0.29	0.48	0.34	0.43	0.90	1.83	1.04	0.37	0.71
QSI-taxa									
90 vs 91	0.67	0.77	0.60	0.58	0.53	0.00	0.22	0.43	0.48
QSI-FFG									
90 vs 91	0.87	0.97	0.79	0.87	0.53	0.14	0.86	0.88	0.74
DIC-5									
90 vs 91	3	4	3	4	3	0	1	2	2.5

Table 13. Metric variability between 1990 and 1991 at eight Montana reference stream sites: sample size standardized (300 organisms where possible).

	STREAM								Mean	Sign test
Metric	Bould	WF St	SF Su	Seym	WF Pop	Redw	Rock	Armst	C.V.	P value
Taxa richness										0.07
1990	30	29	36	44	24	11	37	20		
1991	23	23	32	37	18	13	23	19		
S.D.	4.7	4.2	2.8	4.9	4.5	1.4	9.9	0.7		
C.V.	18%	16%	8%	12%	21%	12%	33%	4%	16%	
EPT richness										0.79
1990	23	20	24	25	7	1	4	5		
1991	17	18	23	29	10	3	3	3		
S.D.	4.2	1.4	0.7	2.8	2.3	1.4	0.7	1.4		
C.V.	21%	7%	3%	10%	28%	71%	20%	35%	25%	
Biotic index										0.29
1990	1.7	1.6	2.0	2.7	6.7	7.5	7.2	5.3		
1991	1.8	1.0	1.2	1.5	6.0	5.2	6.1	5.7		
S.D.	0.1	0.4	0.6	0.9	0.5	1.6	0.8	0.3		
C.V.	5%	31%	35%	41%	8%	26%	12%	6%	20%	
CTQa (%RA)										0.99
1990	33	31	33	53	100	105	103	105		
1991	43	31	25	38	89	107	105	105		
S.D.	7.1	0.0	5.7	10.6	7.8	1.4	1.4	0.0		
C.V.	19%	0%	20%	23%	8%	1%	1%	0%	9%	
S. diversity										0.29
1990	3.6	3.3	4.1	4.8	2.6	2.9	4.3	3.2		
1991	3.3	2.8	3.5	4.5	2.8	1.1	2.8	3.3		
S.D.	0.2	0.4	0.5	0.2	0.1	1.3	1.1	0.0		
C.V.	5%	12%	12%	5%	5%	63%	31%	2%	17%	
% Dominant										0.07
1990	26	35	23	11	56	31	14	19		
1991	30	36	24	15	35	77	50	22		
S.D.	2.8	0.7	0.7	2.8	14.8	32.5	25.5	2.1		
C.V.	10%	2%	3%	22%	33%	60%	80%	10%	27%	
% Chironomidae										0.99
1990	2	6	13	26	12	48	53	39		
1991	5	1	2	10	1	12	65	65		
S.D.	2.1	3.5	7.8	11.3	7.8	25.5	8.5	18.4		
C.V.	61%	101%	104%	63%	120%	85%	14%	35%	73%	

Table 13 Concluded.

Metric	STREAM								Mean C.V.	Sign test P value
	Bould	WF St	SF Su	Seym	WF Pop	Redw	Rock	Armst		
EPT/EPTC										0.29
1990	0.98	0.95	0.86	0.72	0.62	0.14	0.13	0.46		
1991	0.95	0.99	0.98	0.89	0.96	0.87	0.16	0.06		
S.D.	0.02	0.03	0.08	0.12	0.24	0.52	0.02	0.28		
C.V.	2%	3%	9%	15%	30%	102%	15%	109%	36%	
Baetidae/Ephemeroptera										0.73
1990	0.21	0.08	0.06	0.15	0.80	0.00	0.05	1.00		
1991	0.39	0.13	0.10	0.10	0.37	1.00	0.13	0.85		
S.D.	0.13	0.04	0.03	0.04	0.30	0.71	0.06	0.11		
C.V.	42%	34%	35%	28%	52%	141%	63%	11%	51%	
% C-gatherers										0.99
1990	27	19	47	44	21	62	60	76		
1991	36	22	12	23	42	14	72	84		
S.D.	6.4	2.1	24.7	14.8	14.8	33.9	8.5	5.7		
C.V.	20%	10%	84%	44%	47%	89%	13%	7%	39%	
% Scrapers										0.73
1990	60	73	31	28	1	0	0	0		
1991	47	71	74	41	6	0	1	0		
S.D.	9.2	1.4	30.4	9.2	3.5	0.0	0.7	0.2		
C.V.	17%	2%	58%	27%	101%		141%	141%	70%	
Mean C.V. all metrics	20%	20%	34%	26%	41%	65%	38%	33%	35%	

Figure 1. Taxa richness in nine samples of varying size (number of organisms) from the Boulder River during August, 1992.

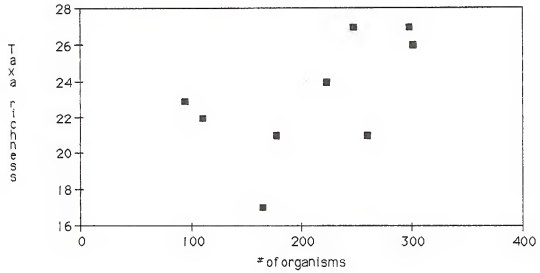


Figure 2. EPT richness in nine samples of varying size (number of organisms) from the Boulder River during August, 1992.

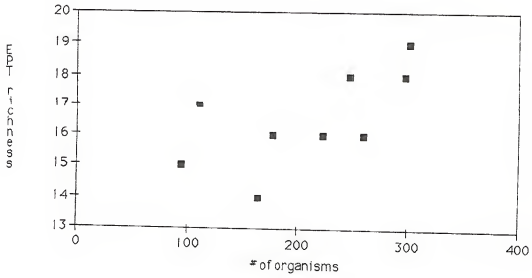


Figure 3. The effect of sample size (number of organisms) on taxa richness in subsamples of *macroinvertebrates* collected from the Boulder River.

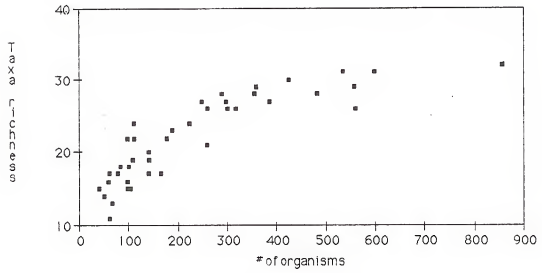
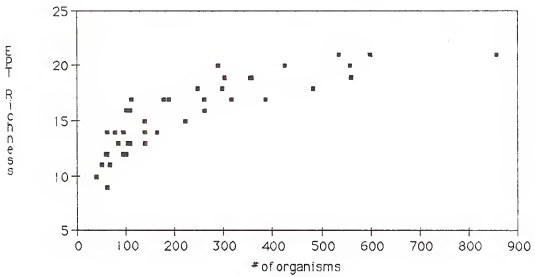


Figure 4. The effect of sample size (number of organisms) on EPT richness in subsamples of macroinvertebrates collected from the Boulder River.



APPENDIX A:

AQUATIC MACROINVERTEBRATE DATA
MONTANA REFERENCE STREAMS
1991

AQUATIC MACROINVERTEBRATE DATA

BOULDER RIVER - second order - 22 Aug 91

riffle:	3.1	3.2	3.3	SUM	MEAN	ST. DEV.	Co. VAR	%RA
Taxon								
DIPTERA								
Cricotopus nostococladius	2	2	2	6	2.0	0.0	0%	0.7%
Eukiefferiella spp.	6	2	1	9	3.0	2.6	88%	1.1%
Orthocladius spp.	3	1	0	4	1.3	1.5	115%	0.5%
Parametriocnemus sp.	1	0	0	1	0.3	0.6	173%	0.1%
Tvetenia sp.	4	0	0	4	1.3	2.3	173%	0.5%
Micropsectra spp.	3	1	2	6	2.0	1.0	50%	0.7%
Hexatoma sp.	3	2	1	6	2.0	1.0	50%	0.7%
Tipulidae	0	2	0	2	0.7	1.2	173%	0.2%
Simulium spp. (Eusimuluim)	1	0	0	1	0.3	0.6	173%	0.1%
EPHEMEROPTERA								
Baetis bicaudatus	14	18	46	78	26.0	17.4	67%	9.1%
Ameletus spp.	1	3	7	11	3.7	3.1	83%	1.3%
Serratella micheneri	2	0	0	2	0.7	1.2	173%	0.2%
Drunella coloradensis	12	5	4	21	7.0	4.4	62%	2.5%
Drunella doddsi	4	13	3	20	6.7	5.5	83%	2.3%
Cinygmula spp.	32	47	38	117	39.0	7.5	19%	13.7%
Epeorus albertae	47	41	42	130	43.3	3.2	7%	15.2%
Epeorus grandis	7	2	2	11	3.7	2.9	79%	1.3%
Rhithrogena spp.	16	14	7	37	12.3	4.7	38%	4.3%
PLECOPTERA								
Capniidae	2	1	0	3	1.0	1.0	100%	0.4%
Zapada columbiana	12	21	20	53	17.7	4.9	28%	6.2%
Zapada oregonensis gp.	51	59	44	154	51.3	7.5	15%	18.0%
Kogotus sp.	2	0	0	2	0.7	1.2	173%	0.2%
Megarcys sp.	24	20	13	57	19.0	5.6	29%	6.7%
TRICHOPTERA								
Parapsyche elsis	23	18	10	51	17.0	6.6	39%	6.0%
Dicosmoecus sp.	0	1	1	2	0.7	0.6	87%	0.2%
Neothremma sp.	0	1	0	1	0.3	0.6	173%	0.1%
Rhyacophila betteni gp.	3	1	0	4	1.3	1.5	115%	0.5%
Rhyacophila iranda gp.	4	5	7	16	5.3	1.5	29%	1.9%
Rhyacophila hylinata gp.	10	2	1	13	4.3	4.9	114%	1.5%
Rhyacophila sibrica gp.	0	1	2	3	1.0	1.0	100%	0.4%
OTHER								
Turbellaria	8	18	6	32	10.7	6.4	60%	3.7%

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AQUATIC MACROINVERTEBRATE DATA

BOULDER RIVER - second order - 22 Aug 91

riffle:	3.1	3.2	3.3	SUM	MEAN	ST. DEV.	Co. VAR	%RA
TOTAL ORGANISMS	297	301	259	857	285.7	23.2	8%	
TAXA RICHNESS	27	26	21	31	24.7	3.2	13%	
EPT RICHNESS	18	19	16	21	17.7	1.5	9%	
BIOTIC INDEX	1.02	0.95	1.05	1.00	1.01	0.05	5%	
SHANNON DIVERSITY	3.93	3.67	3.45	3.81	3.68	0.24	7%	
CTQa (% relative abundance)	30	30	34	31	31	2	7%	
EPT/(EPT + Chironomidae)	0.93	0.98	0.98	0.96	0.96	0.03	3%	
% DOMINANT TAXON	17%	20%	18%	18%	18%	1%	7%	
% COLLECTOR-GATHERERS	11%	7%	19%	12%	12%	6%	48%	
% SHREDDERS	22%	28%	25%	25%	25%	3%	12%	
% SCRAPERS	40%	42%	40%	41%	41%	1%	3%	
% FILTERERS	8%	6%	4%	6%	6%	2%	35%	
% PREDATORS	18%	16%	12%	16%	15%	3%	22%	
% CHIRONOMIDAE	6%	2%	2%	4%	3%	3%	74%	
% COLEOPTERA	0%	0%	0%	0%	0%	0%	#DIV/0!	
% DIPTERA	8%	3%	2%	5%	4%	3%	65%	
% EPHEMEROPTERA	45%	48%	58%	50%	50%	6%	13%	
% PLECOPTERA	31%	34%	30%	31%	31%	2%	6%	
% TRICHOPTERA	13%	10%	8%	11%	10%	3%	27%	
% misc INSECTS	0%	0%	0%	0%	0%	0%	#DIV/0!	
% ANNELIDA	0%	0%	0%	0%	0%	0%	#DIV/0!	
% MOLLUSCA	0%	0%	0%	0%	0%	0%	#DIV/0!	
% CRUSTACEA	0%	0%	0%	0%	0%	0%	#DIV/0!	
% misc NONINSECTS	3%	6%	2%	4%	4%	2%	55%	
Baetidae/EPHEMEROPTERA	10%	13%	31%	18%	18%	11%	63%	
Hydropsychinae/TRICH	0%	0%	0%	0%	0%	0%	#DIV/0!	
100 organism subsample								
Taxa richness	24	19	17		20.0	3.6	18%	
EPT richness	16	17	13		15.3	2.1	14%	

AQUATIC MACROINVERTEBRATE DATA

BOULDER RIVER - third order - 22 Aug 91

riffle:	2.1	2.2	2.3	SUM	MEAN	ST. DEV.	Co.VAR	%RA
Taxon								
COLEOPTERA								
Optioservus spp.	1	0	1	2	0.7	0.6	87%	0.4%
DIPTERA								
Diamesa sp.	2	2	1	5	1.7	0.6	35%	1.0%
Cricotopus spp.	2	0	1	3	1.0	1.0	100%	0.6%
Cricotopus nostococladius	4	0	3	7	2.3	2.1	89%	1.5%
Eukiefferiella spp.	1	0	5	6	2.0	2.6	132%	1.2%
Orthocladius spp.	1	0	1	2	0.7	0.6	87%	0.4%
Tvetenia sp.	7	0	1	8	2.7	3.8	142%	1.7%
Antocha sp.	0	1	0	1	0.3	0.6	173%	0.2%
Hexatoma sp.	0	0	1	1	0.3	0.6	173%	0.2%
Simulium spp. (Eusimuluim)	1	1	0	2	0.7	0.6	87%	0.4%
EPHEMEROPTERA								
Baetis bicaudatus	14	17	20	51	17.0	3.0	18%	10.6%
Drunella coloradensis	1	1	3	5	1.7	1.2	69%	1.0%
Drunella doddsi	0	1	1	2	0.7	0.6	87%	0.4%
Cinygmula spp.	4	3	14	21	7.0	6.1	87%	4.4%
Epeorus albertae	13	34	40	87	29.0	14.2	49%	18.1%
Epeorus grandis	11	61	9	81	27.0	29.5	109%	16.8%
Rhithrogena spp.	5	12	39	56	18.7	18.0	96%	11.6%
PLECOPTERA								
Doroneuria theodora	0	0	2	2	0.7	1.2	173%	0.4%
Zapada columbiana	3	1	5	9	3.0	2.0	67%	1.9%
Zapada oregonensis gp.	7	6	11	24	8.0	2.6	33%	5.0%
Megarcys sp.	6	10	21	37	12.3	7.8	63%	7.7%
TRICHOPTERA								
Parapsyche elsis	2	1	14	17	5.7	7.2	128%	3.5%
Hydropsyche tana/oslari	1	0	0	1	0.3	0.6	173%	0.2%
Dicosmoecus sp.	1	0	1	2	0.7	0.6	87%	0.4%
Brachycentrus americanus	0	1	0	1	0.3	0.6	173%	0.2%
Rhyacophila iranda gp.	1	2	10	13	4.3	4.9	114%	2.7%
Rhyacophila hyalinata gp.	6	10	16	32	10.7	5.0	47%	6.7%
Rhyacophila sibirica gp.	1	0	2	3	1.0	1.0	100%	0.6%

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AQUATIC MACROINVERTEBRATE DATA

BOULDER RIVER - third order - 22 Aug 91

riffle:	2.1	2.2	2.3	SUM	MEAN	ST. DEV.	Co.VAR	%RA
TOTAL ORGANISMS	95	164	222	481	160.3	63.6	40%	
TAXA RICHNESS	23	17	24	28	21.3	3.8	18%	
EPT RICHNESS	15	14	16	18	15.0	1.0	7%	
BIOTIC INDEX	1.92	0.78	1.16	1.18	1.28	0.58	45%	
SHANNON DIVERSITY	3.96	2.86	3.72	3.73	3.51	0.58	16%	
CTQa (% relative abundance)	46	28	30	32	35	10	30%	
EPT/(EPT + Chironomidae)	0.82	0.99	0.95	0.93	0.92	0.09	10%	
% DOMINANT TAXON	15%	37%	18%	18%	23%	12%	52%	
% COLLECTOR-GATHERERS	28%	12%	13%	16%	18%	9%	51%	
% SHREDDERS	11%	4%	7%	7%	7%	3%	43%	
% SCRAPERS	38%	69%	49%	53%	52%	16%	30%	
% FILTERERS	4%	1%	6%	4%	4%	3%	65%	
% PREDATORS	15%	13%	23%	18%	17%	5%	32%	
% CHIRONOMIDAE	18%	1%	5%	6%	8%	9%	106%	
% COLEOPTERA	1%	0%	0%	0%	1%	1%	105%	
% DIPTERA	19%	2%	6%	7%	9%	9%	96%	
% EPHEMEROPTERA	51%	79%	57%	63%	62%	15%	24%	
% PLECOPTERA	17%	10%	18%	15%	15%	4%	27%	
% TRICHOPTERA	13%	9%	19%	14%	14%	5%	40%	
Baetidae/EPHEMEROPTERA	29%	13%	16%	17%	19%	9%	44%	
Hydropsychinae/TRICH	8%	0%	0%	1%	3%	5%	173%	
100 organism subsample								
Taxa richness	22	16	19		19.0	3.0	16%	
EPT richness	14	13	14		13.7	0.6	4%	

AQUATIC MACROINVERTEBRATE DATA

BOULDER RIVER - fourth order - 22 Aug 91

riffle:	1.1	1.2	1.3	SUM	MEAN	ST. DEV.	Co. VAR	%RA
Taxon								
COLEOPTERA								
Heterlimnius corpulentus	1	0	0	1	0.3	0.6	173%	0.2%
DIPTERA								
unassociated midge pupa	0	0	2	2	0.7	1.2	173%	0.4%
Cricotopus nostococladius	1	0	1	2	0.7	0.6	87%	0.4%
Eukiefferiella spp.	1	1	1	3	1.0	0.0	0%	0.6%
Orthocladius spp.	0	2	14	16	5.3	7.6	142%	3.0%
Rheocricotopus sp.	0	1	1	2	0.7	0.6	87%	0.4%
Thienemanniella sp.	0	0	1	1	0.3	0.6	173%	0.2%
Tvetenia sp.	3	0	4	7	2.3	2.1	89%	1.3%
Clinocera sp.	0	0	1	1	0.3	0.6	173%	0.2%
EPHEMEROPTERA								
Baetis bicaudatus	45	35	81	161	53.7	24.2	45%	30.1%
Ameletus spp.	1	6	5	12	4.0	2.6	66%	2.2%
Serratella micheneri	0	1	1	2	0.7	0.6	87%	0.4%
Drunella coloradensis	2	2	1	5	1.7	0.6	35%	0.9%
Drunella doddsi	4	4	11	19	6.3	4.0	64%	3.6%
Cinygmula spp.	13	7	6	26	8.7	3.8	44%	4.9%
Epeorus albertae	42	22	70	134	44.7	24.1	54%	25.1%
Epeorus grandis	18	4	15	37	12.3	7.4	60%	6.9%
Rhithrogena spp.	5	4	5	14	4.7	0.6	12%	2.6%
PLECOPTERA								
Zapada oregonensis gp.	3	3	4	10	3.3	0.6	17%	1.9%
Zapada columbiana	0	1	2	3	1.0	1.0	100%	0.6%
Megarcys sp.	17	5	7	29	9.7	6.4	67%	5.4%
Chloroperlinae	1	1	2	4	1.3	0.6	43%	0.7%
TRICHOPTERA								
Hydropsyche oslari/tana	1	0	0	1	0.3	0.6	173%	0.2%
Parapsyche elsis	5	4	3	12	4.0	1.0	25%	2.2%
Oligophlebodes sp.	1	0	2	3	1.0	1.0	100%	0.6%
Dicosmoecus sp.	0	0	1	1	0.3	0.6	173%	0.2%
Ecclisomyia sp.	0	2	0	2	0.7	1.2	173%	0.4%
Rhyacophila betteni gp.	0	1	1	2	0.7	0.6	87%	0.4%
Rhyacophila hyalinata gp.	11	1	2	14	4.7	5.5	118%	2.6%
Rhyacophila sibirica gp.	1	0	0	1	0.3	0.6	173%	0.2%
OTHER	1	3	3	7	2.3	1.2	49%	1.3%
Turbellaria	0	1	0	1	0.3	0.6	173%	0.2%
Porifera								

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AQUATIC MACROINVERTEBRATE DATA

BOULDER RIVER - fourth order - 22 Aug 91

riffle:	1.1	1.2	1.3	SUM	MEAN	ST. DEV.	Co. VAR	%RA
TOTAL ORGANISMS	177	111	247	534	178.3	68.0	38%	
TAXA RICHNESS	21	22	27	31	23.3	3.2	14%	
EPT RICHNESS	16	17	18	21	17.0	1.0	6%	
BIOTIC INDEX	1.40	1.76	2.11	1.80	1.76	0.36	20%	
SHANNON DIVERSITY	3.25	3.44	3.15	3.37	3.28	0.15	5%	
CTQa (% relative abundance)	38	43	47	43	43	5	11%	
EPT/(EPT + Chironomidae)	0.97	0.96	0.90	0.94	0.95	0.04	4%	
% DOMINANT TAXON	25%	32%	33%	30%	30%	4%	13%	
% COLLECTOR-GATHERERS	28%	36%	43%	37%	36%	7%	20%	
% SHREDDERS	2%	4%	2%	2%	3%	1%	37%	
% SCRAPERS	49%	46%	47%	47%	47%	1%	3%	
% FILTERERS	3%	4%	1%	2%	3%	1%	48%	
% PREDATORS	18%	10%	6%	11%	11%	6%	50%	
% CHIRONOMIDAE	3%	4%	10%	6%	5%	4%	70%	
% COLEOPTERA	1%	0%	0%	0%	0%	0%	173%	
% DIPTERA	3%	4%	10%	6%	6%	4%	73%	
% EPHEMEROPTERA	73%	77%	79%	77%	76%	3%	4%	
% PLECOPTERA	12%	9%	6%	9%	9%	3%	32%	
% TRICHOPTERA	11%	7%	4%	7%	7%	4%	49%	
% misc NONINSECTS	1%	4%	1%	1%	2%	2%	89%	
Baetidae/EPHEMEROPTERA	35%	41%	42%	39%	39%	4%	10%	
Hydropsychinae/TRICH	5%	0%	0%	3%	2%	3%	173%	
100 organism subsample								
Taxa richness	15	22	20		19.0	3.6	19%	
EPT richness	12	17	14		14.3	2.5	18%	

AQUATIC MACROINVERTEBRATE DATA
WEST FORK STILLWATER RIVER - 15 Aug 91

Taxon	Number	%RA
DIPTERA		
Eukiefferiella spp.	2	0.7%
Orthocladius spp.	1	0.3%
Micropsectra spp.	1	0.3%
Hexatoma sp.	3	1.0%
EPHEMEROPTERA		
Baetis bicaudatus	36	11.9%
Ephemerella aurivilli	7	2.3%
Drunella coloradensis	16	5.3%
Drunella doddsi	3	1.0%
Cinygmula spp.	85	28.1%
Epeorus albertae	109	36.0%
Epeorus longimanus	4	1.3%
Epeorus grandis	1	0.3%
Rhithrogena spp.	12	4.0%
PLECOPTERA		
Doroneuria sp.	4	1.3%
Zapada oregenensis.	3	1.0%
Megarcys sp.	3	1.0%
Chloroperlinae	1	0.3%
TRICHOPTERA		
Parapsyche elsis	1	0.3%
Rhyacophila betteni gp.	1	0.3%
Rhyacophila brunnea gp.	4	1.3%
Rhyacophila hyalinata gp.	2	0.7%
Rhyacophila alberta gp.	1	0.3%
ANNELIDA		
Enchytraeidae	3	1.0%

ID's by D. McGuire

AQUATIC MACROINVERTEBRATE DATA
WEST FORK STILLWATER RIVER - 15 Aug 91

TOTAL ORGANISMS	303
TAXA RICHNESS	23
EPT RICHNESS	18
BIOTIC INDEX	0.97
SHANNON DIVERSITY	2.81
CTQa (% relative abundance)	31
EPT/(EPT + Chironomidae)	0.99
% DOMINANT TAXON	36%
% COLLECTOR-GATHERERS	22%
% SHREDDERS	1%
% SCRAPERS	71%
% FILTERERS	0%
% PREDATORS	6%
% CHIRONOMIDAE	1%
% COLEOPTERA	0%
% DIPTERA	2%
% EPHEMEROPTERA	90%
% PLECOPTERA	4%
% TRICHOPTERA	3%
% misc INSECTS	#REF!
% ANNELIDA	1%
% MOLLUSCA	#REF!
% CRUSTACEA	#REF!
% misc NONINSECTS	100%
Baetidae/EPHEMEROPTERA	13%
Hydropsychinae/TRICH	#REF!

AQUATIC MACROINVERTEBRATE DATA
SOUTH FORK SUN RIVER - 4 Sept 91

Taxon	Number	%RA
COLEOPTERA		
Heterlimnius corpulentus	1	0.3%
DIPTERA		
Diamesa sp.	2	0.7%
Eukiefferiella spp.	1	0.3%
Orthocladius spp.	1	0.3%
Micropsectra spp.	2	0.7%
Agathon sp.	4	1.3%
Hexatoma sp.	6	2.0%
Simulium spp. (Eusimuluim)	1	0.3%
EPHEMEROPTERA		
Baetis bicaudatus	25	8.1%
Caudatella sp.	1	0.3%
Serratella micheneri	3	1.0%
Drunella coloradensis	3	1.0%
Drunella doddsi	62	20.2%
Cinygmula spp.	14	4.6%
Epeorus albertae	73	23.8%
Epeorus longimanus	3	1.0%
Epeorus grandis	3	1.0%
Rhithrogena spp.	59	19.2%
PLECOPTERA		
Doroneuria sp.	2	0.7%
Zapada oregenensis	4	1.3%
Megarcys sp.	4	1.3%
Chloroperlinae	5	1.6%
TRICHOPTERA		
Arctopsyche grandis	3	1.0%
Parapsyche elsis	1	0.3%
Oligophlebodes sp.	1	0.3%
Dicosmoecus sp.	1	0.3%
Brachycentrus americanus	4	1.3%
Rhyacophila betteni gp.	1	0.3%
Rhyacophila brunnea gp.	8	2.6%
Rhyacophila hylinata gp.	7	2.3%
Rhyacophila sibrica gp.	1	0.3%
ANNELIDA		
Lumbricidae	1	0.3%

ID's by D. McGuire

AQUATIC MACROINVERTEBRATE DATA
SOUTH FORK SUN RIVER - 4 Sept 91

TOTAL ORGANISMS	307
TAXA RICHNESS	32
EPT RICHNESS	23
BIOTIC INDEX	1.20
SHANNON DIVERSITY	3.47
CTQa (% relative abundance)	25
EPT/(EPT + Chironomidae)	0.98
% DOMINANT TAXON	24%
% COLLECTOR-GATHERERS	12%
% SHREDDERS	1%
% SCRAPERS	74%
% FILTERERS	2%
% PREDATORS	11%
% CHIRONOMIDAE	2%
% COLEOPTERA	0%
% DIPTERA	6%
% EPHEMEROPTERA	80%
% PLECOPTERA	5%
% TRICHOPTERA	9%
% misc INSECTS	#REF!
% ANNELIDA	8%
% MOLLUSCA	#REF!
% CRUSTACEA	#REF!
% misc NONINSECTS	#REF!
Baetidae/EPHEMEROPTERA	10%
Hydropsychinae/TRICH	#REF!

AQUATIC MACROINVERTEBRATE DATA
SEYMOUR CREEK - reference station - 26 July 91

Taxon	Number	%RA
COLEOPTERA		
Heterlimnius corpulentus	7	2.3%
DIPTERA		
Brillia sp.	1	0.3%
Eukiefferiella spp.	13	4.3%
Tvetenia sp.	3	1.0%
Micropsectra spp.	12	4.0%
Prosimulium sp.	13	4.3%
EPHEMEROPTERA		
Baetis bicaudatus/tricaudatus	15	5.0%
Serratella micheneri	5	1.7%
Drunella coloradensis	7	2.3%
Drunella doddsi	8	2.7%
Drunella spinifera	7	2.3%
Caudatella edmundsi	1	0.3%
Caudatella hystrix	3	1.0%
Cinygmula spp.	44	14.7%
Epeorus alberta	34	11.4%
Epeorus longimanus	16	5.4%
Epeorus grandis	2	0.7%
Rhithrogena spp.	8	2.7%
PLECOPTERA		
Doroneuria sp.	9	3.0%
Zapada columbiana	8	2.7%
Zapada oregonensis gp.	2	0.7%
Kogotus sp.	1	0.3%
Megarcys sp.	11	3.7%
Isoperla sp.	1	0.3%
Yoraperla sp.	2	0.7%
TRICHOPTERA		
Parapsyche sp.	28	9.4%
Lepidostoma sp.	4	1.3%
Glossosoma sp.	3	1.0%
Rhyacophila betteni gp.	7	2.3%
Rhyacophila brunnea gp.	6	2.0%
Rhyacophila alberta gp.	1	0.3%
Rhyacophila verrula gp.	2	0.7%
Rhyacophila iranda gp.	3	1.0%
Rhyacophila hyalinata gp.	3	1.0%
Rhyacophila sibirica gp.	4	1.3%
ANNELIDA		
Enchytraeidae	3	1.0%
OTHER		
Turbellaria	2	0.7%

AQUATIC MACROINVERTEBRATE DATA
SEYMOUR CREEK - reference station - 26 July 91

TOTAL ORGANISMS	299
TAXA RICHNESS	37
EPT RICHNESS	29
BIOTIC INDEX	1.52
SHANNON DIVERSITY	4.52
CTQa (% relative abundance)	38
EPT/(EPT + Chironomidae)	0.89
% DOMINANT TAXON	15%
% COLLECTOR-GATHERERS	23%
% SHREDDERS	5%
% SCRAPERS	41%
% FILTERERS	14%
% PREDATORS	16%
% CHIRONOMIDAE	10%
% COLEOPTERA	2%
% DIPTERA	14%
% EPHEMEROPTERA	50%
% PLECOPTERA	11%
% TRICHOPTERA	20%
% misc INSECTS	#REF!
% ANNELIDA	1%
% MOLLUSCA	#REF!
% CRUSTACEA	#REF!
% misc NONINSECTS	1%
Baetidae/EPHEMEROPTERA	10%
Hydropsychinae/TRICH	#REF!

AQUATIC MACROINVERTEBRATE DATA
REDWATER RIVER - 20 Aug 91

Taxon	Number	%RA
DIPTERA		
Thienemannimyia gp.	2	0.7%
Cricotopus spp.	11	3.7%
Polypedilum sp.	10	3.4%
Rheotanytarsus sp.	13	4.4%
Micropsectra spp.	1	0.3%
Tabanidae	3	1.0%
Simulium sp.	2	0.7%
EPHEMEROPTERA		
Baetis propinquis	5	1.7%
TRICHOPTERA		
Cheumatopsyche sp.	229	77.1%
Hydropsyche bronta	'18	6.1%
HEMIPTERA		
Sigara sp.	1	0.3%
MEGALOPTERA		
Sialis sp.	1	0.3%
ANNELIDA		
Tubificidae	1	0.3%

ID's by D. McGuire

AQUATIC MACROINVERTEBRATE DATA
REDWATER RIVER - 20 Aug 91

TOTAL ORGANISMS	297
TAXA RICHNESS	13
EPT RICHNESS	3
BIOTIC INDEX	5.21
SHANNON DIVERSITY	1.45
CTQa (% relative abundance)	107
EPT/(EPT + Chironomidae)	0.87
% DOMINANT TAXON	77%
% COLLECTOR-GATHERERS	14%
% SHREDDERS	0%
% SCRAPERS	0%
% FILTERERS	84%
% PREDATORS	2%
% CHIRONOMIDAE	12%
% COLEOPTERA	#REF!
% DIPTERA	14%
% EPHEMEROPTERA	2%
% PLECOPTERA	#REF!
% TRICHOPTERA	83%
% misc INSECTS	1%
% ANNELIDA	0%
% MOLLUSCA	#REF!
% CRUSTACEA	#REF!
% misc NONINSECTS	#REF!
Baetidae/EPHEMEROPTERA	100%
Hydropsychinae/TRICH	100%

AQUATIC MACROINVERTEBRATE DATA
ROCK CREEK - NE of HINSDALE - 21 Aug 91

Taxon	Number	%RA
COLEOPTERA		
Helophorus sp.	1	0.3%
DIPTERA		
Ablabesmyia sp.	9	3.0%
Thienemannimyia gp.	2	0.7%
Cricotopus spp.	11	3.6%
Thienemanniella sp.	1	0.3%
Demicryptochironomus sp.	1	0.3%
Dicrotendipes sp.	7	2.3%
Glyptotendipes sp.	2	0.7%
Parachironomus sp.	2	0.7%
Phaenopsectra sp.	8	2.6%
Polypedilum sp.	2	0.7%
Tanytarsus sp.	153	50.3%
Ormosia sp.	1	0.3%
Aedes sp.	8	2.6%
Culex sp.	2	0.7%
EPHEMEROPTERA		
Baetis propinquis	3	1.0%
Caenis sp.	17	5.6%
TRICHOPTERA		
Cheumatopsyche sp.	17	5.6%
HEMIPTERA		
Sigara sp.	49	16.1%
CRUSTACEA		
Gammarus sp.	3	1.0%
Hyallela aztecu	1	0.3%
MOLLUSCA		
Physidae	3	1.0%
ANNELIDA		
Naididae	1	0.3%

ID's by D. McGuire

AQUATIC MACROINVERTEBRATE DATA
ROCK CREEK - NE of HINSDALE - 21 Aug 91

TOTAL ORGANISMS	304
TAXA RICHNESS	23
EPT RICHNESS	3
BIOTIC INDEX	6.04
SHANNON DIVERSITY	2.71
CTQa (% relative abundance)	105
EPT/(EPT + Chironomidae)	0.16
% DOMINANT TAXON	50%
% COLLECTOR-GATHERERS	72%
% SHREDDERS	1%
% SCRAPERS	1%
% FILTERERS	6%
% PREDATORS	20%
% CHIRONOMIDAE	65%
% COLEOPTERA	0%
% DIPTERA	69%
% EPHEMEROPTERA	7%
% PLECOPTERA	#REF!
% TRICHOPTERA	6%
% misc INSECTS	16%
% ANNELIDA	0%
% MOLLUSCA	1%
% CRUSTACEA	1%
% misc NONINSECTS	#REF!
Baetidae/EPHEMEROPTERA	15%
Hydropsychinae/TRICH	100%

AQUATIC MACROINVERTEBRATE DATA

WEST FORK POPLAR RIVER - above HAPPY VALLEY (second order) - 91 07 23

Sample:	1	2	3	SUM	MEAN	ST. DEV.	Co.VAR%	%RA
Taxon								
COLEOPTERA								
Curculionidae	0	1	0	1	0.3	0.6	173%	0.1%
Hydrophilidae	1	0	0	1	0.3	0.6	173%	0.1%
DIPTERA								
Thienemannimyia gp.	6	3	0	9	3.0	3.0	100%	0.9%
Cricotopus spp.	43	39	25	107	35.7	9.5	26%	11.0%
Dicrotendipes sp.	5	3	2	10	3.3	1.5	46%	1.0%
Endochironomus sp.	0	0	3	3	1.0	1.7	173%	0.3%
Glyptotendipes sp.	3	5	10	18	6.0	3.6	60%	1.9%
Parachironomus sp.	2	2	19	23	7.7	9.8	128%	2.4%
Paratanytarsus sp.	4	7	0	11	3.7	3.5	96%	1.1%
Micropsectra spp.	0	2	1	3	1.0	1.0	100%	0.3%
Simulium sp. (Psilozia)	30	20	37	87	29.0	8.5	29%	9.0%
EPHEMEROPTERA								
Caenis sp.	1	1	0	2	0.7	0.6	87%	0.2%
TRICHOPTERA								
Limnophilus sp.	1	0	1	2	0.7	0.6	87%	0.2%
Hydroptila spp.	1	1	1	3	1.0	0.0	0%	0.3%
Mystacides sp.	0	0	2	2	0.7	1.2	173%	0.2%
Nectopsyche sp.	0	0	3	3	1.0	1.7	173%	0.3%
Oecetis sp.	3	1	3	7	2.3	1.2	49%	0.7%
Polycentropus sp.	0	0	1	1	0.3	0.6	173%	0.1%
Molanna sp.	0	2	1	3	1.0	1.0	100%	0.3%
HEMIPTERA								
Trichocorixa naias	17	11	5	33	11.0	6.0	55%	3.4%
ODONATA								
Ischnura sp.	1	0	0	1	0.3	0.6	173%	0.1%
ANNELIDA								
Tubificidae	0	1	0	1	0.3	0.6	173%	0.1%
Erpobdellidae	0	4	5	9	3.0	2.6	88%	0.9%
CRUSTACEA								
Gammarus sp.	29	33	48	110	36.7	10.0	27%	11.3%
Hyallela azteca	120	113	130	363	121.0	8.5	7%	37.3%
MOLLUSCA								
Physidae	6	6	7	19	6.3	0.6	9%	2.0%
Lymnaedae	17	23	0	40	13.3	11.9	89%	4.1%
Gyraulus sp.	30	54	13	97	32.3	20.6	64%	10.0%
OTHER								
Bryozoa	1	1	1	3	1.0	0.0	0%	0.3%
Hydracarina	1	0	1	2	0.7	0.6	87%	0.2%

AQUATIC MACROINVERTEBRATE DATA

WEST FORK POPLAR RIVER - above HAPPY VALLEY (second order) - 91 07 23

Sample:	1	2	3	SUM	MEAN	ST. DEV.	Co.VAR%	%RA
Taxon								
TOTAL ORGANISMS	322	333	319	972	324.7	7.4	2%	
TAXA RICHNESS	21	22	22	29	21.7	0.6	3%	
EPT RICHNESS	4	4	7	8	5.0	1.7	35%	
BIOTIC INDEX	7.19	7.19	7.24	7.21	7.20	0.03	0%	
SHANNON DIVERSITY	3.06	3.12	2.95	3.16	3.04	0.09	3%	
CTQa (% relative abundance)	103	103	101	102	102	1	1%	
EPT/(EPT + Chironomidae)	0.09	0.08	0.17	0.11	0.11	0.05	45%	
% DOMINANT TAXON	37%	34%	41%	37%	37%	3%	9%	
% COLLECTOR-GATHERERS	17%	16%	9%	14%	14%	4%	29%	
% SHREDDERS	48%	46%	61%	51%	51%	8%	16%	
% SCRAPERS	17%	26%	7%	17%	16%	9%	57%	
% FILTERERS	10%	6%	12%	9%	9%	3%	30%	
% PREDATORS	9%	6%	10%	9%	9%	2%	24%	
% CHIRONOMIDAE	20%	18%	19%	19%	19%	1%	3%	
% COLEOPTERA	0%	0%	0%	0%	0%	0%	87%	
% DIPTERA	29%	24%	30%	28%	28%	3%	11%	
% EPHEMEROPTERA	0%	0%	0%	0%	0%	0%	87%	
% PLECOPTERA	0%	0%	0%	0%	0%	0%	#DIV/0!	
% TRICHOPTERA	2%	1%	4%	2%	2%	1%	64%	
% misc INSECTS	6%	3%	2%	3%	3%	2%	58%	
% ANNELIDA	0%	2%	2%	1%	1%	1%	87%	
% MOLLUSCA	16%	25%	6%	16%	16%	9%	59%	
% CRUSTACEA	46%	44%	56%	49%	49%	6%	13%	
% misc NONINSECTS	1%	0%	1%	1%	1%	0%	36%	
Bactidae/EPHEMEROPTERA	0%	0%	0%	0%	0%	0%	#DIV/0!	
Hydropsychinae/TRICH	0%	0%	0%	0%	0%	0%	#DIV/0!	

AQUATIC MACROINVERTEBRATE DATA

WEST FORK POPLAR RIVER - above HWY 13 (third order) - 91 07 23

riffle:	4	5	6	SUM	MEAN	ST. DEV.	Co.VAR%	%RA
Taxon								
DIPTERA								
Thienemannimyia gp.	4	2	3	9	3.0	1.0	33%	0.9%
Cricotopus spp.	0	2	3	5	1.7	1.5	92%	0.5%
Simulium sp. (Psilozia)	104	112	126	342	114.0	11.1	10%	34.7%
EPHEMEROPTERA								
Baetis nr. quilleri	6	3	4	13	4.3	1.5	35%	1.3%
Baetis nr. propinquis	33	26	30	89	29.7	3.5	12%	9.0%
Baetis insignificans	2	1	3	6	2.0	1.0	50%	0.6%
Isonychia sp.	46	51	60	157	52.3	7.1	14%	15.9%
Nixe sp.	3	2	5	10	3.3	1.5	46%	1.0%
Caenis sp.	7	3	4	14	4.7	2.1	45%	1.4%
Tricorythodes minutus	4	2	0	6	2.0	2.0	100%	0.6%
TRICHOPTERA								
Cheumatopsyche spp.	0	1	0	1	0.3	0.6	173%	0.1%
Hydroptila spp.	1	0	5	6	2.0	2.6	132%	0.6%
Psychomyia flavida	3	2	0	5	1.7	1.5	92%	0.5%
Polycentropus sp.	0	0	1	1	0.3	0.6	173%	0.1%
Helicopsyche sp	3	12	4	19	6.3	4.9	78%	1.9%
ANNELIDA								
Erpobdellidae	1	2	1	4	1.3	0.6	43%	0.4%
Helobdellidae	0	1	0	1	0.3	0.6	173%	0.1%
CRUSTACEA								
Gammarus sp.	18	22	16	56	18.7	3.1	16%	5.7%
Hyallela azteca	63	77	86	226	75.3	11.6	15%	22.9%
MOLLUSCA								
Physidae	5	2	1	8	2.7	2.1	78%	0.8%
Gyraulus sp.	2	1	5	8	2.7	2.1	78%	0.8%

ID's by D. McGuire

AQUATIC MACROINVERTEBRATE DATA

WEST FORK POPLAR RIVER - above HWY 13 (third order) - 91 07 23

riffle:	4	5	6	SUM	MEAN	ST. DEV.	Co.VAR%	%RA
Taxon								
TOTAL ORGANISMS	305	324	357	986	328.7	26.3	8%	
TAXA RICHNESS	17	19	17	21	17.7	1.2	7%	
EPT RICHNESS	10	10	9	12	9.7	0.6	6%	
BIOTIC INDEX	5.97	5.94	6.05	5.99	5.99	0.06	1%	
SHANNON DIVERSITY	2.84	2.72	2.68	2.78	2.75	0.08	3%	
CTQa (% relative abundance)	89	88	89	89	89	1	1%	
EPT/(EPT + Chironomidae)	0.96	0.96	0.95	0.96	0.96	0.01	1%	
% DOMINANT TAXON	34%	35%	35%	35%	35%	1%	2%	
% COLLECTOR-GATHERERS	17%	11%	12%	13%	14%	3%	22%	
% SHREDDERS	27%	31%	29%	29%	29%	2%	7%	
% SCRAPERS	6%	6%	6%	6%	6%	0%	3%	
% FILTERERS	49%	51%	52%	51%	51%	1%	3%	
% PREDATORS	2%	2%	1%	2%	2%	0%	8%	
% CHIRONOMIDAE	1%	1%	2%	1%	1%	0%	17%	
% COLEOPTERA	0%	0%	0%	0%	0%	0%	#DIV/0!	
% DIPTERA	35%	36%	37%	36%	36%	1%	2%	
% EPHEMEROPTERA	33%	27%	30%	30%	30%	3%	10%	
% PLECOPTERA	0%	0%	0%	0%	0%	0%	#DIV/0!	
% TRICHOPTERA	2%	5%	3%	3%	3%	1%	38%	
% misc INSECTS	0%	0%	0%	0%	0%	0%	#DIV/0!	
% ANNELIDA	0%	1%	0%	1%	1%	0%	70%	
% MOLLUSCA	2%	1%	2%	2%	2%	1%	42%	
% CRUSTACEA	27%	31%	29%	29%	29%	2%	7%	
% misc NONINSECTS	0%	0%	0%	0%	0%	0%	#DIV/0!	
Baetidae/EPHEMEROPTERA	41%	34%	35%	37%	37%	4%	10%	
Hydropsychinae/TRICH	0%	7%	0%	3%	2%	4%	173%	

AQUATIC MACROINVERTEBRATE DATA
ARMSTRONG SPRING CREEK - 12 July 91

Taxon	Number	%RA
DIPTERA		
Pagastia sp.	56	16.6%
Prodiamesa sp.	3	0.9%
Cardiocladius sp.	4	1.2%
Cricotopus spp.	75	22.2%
Eukiefferiella spp.	17	5.0%
Orthocladius spp.	63	18.6%
Tanytarsus sp.	1	0.3%
Micropsectra spp.	1	0.3%
Simulium sp.	1	0.3%
EPHEMEROPTERA		
Baetis tricaudatus	11	3.3%
Ephemerella inermis	2	0.6%
TRICHOPTERA		
Amiocentrus sp.	1	0.3%
CRUSTACEA		
Gammarus sp.	15	4.4%
Asellus sp.	19	5.6%
MOLLUSCA		
Lymnaeidae	13	3.8%
Physidae	22	6.5%
ANNELIDA		
Helobdella stagnalis	1	0.3%
Naididae	32	9.5%
OTHER		
Porifera	1	0.3%

ID's by D. McGuire

AQUATIC MACROINVERTEBRATE DATA
ARMSTRONG SPRING CREEK - 12 July 91

TOTAL ORGANISMS	338
TAXA RICHNESS	19
EPT RICHNESS	3
BIOTIC INDEX	5.74
SHANNON DIVERSITY	3.26
CTQa (% relative abundance)	105
EPT/(EPT + Chironomidae)	0.06
% DOMINANT TAXON	22%
% COLLECTOR-GATHERERS	84%
% SHREDDERS	4%
% SCRAPERS	10%
% FILTERERS	0%
% PREDATORS	0%
% CHIRONOMIDAE	65%
% COLEOPTERA	#REF!
% DIPTERA	65%
% EPHEMEROPTERA	4%
% PLECOPTERA	#REF!
% TRICHOPTERA	0%
% misc INSECTS	#REF!
% ANNELIDA	10%
% MOLLUSCA	10%
% CRUSTACEA	10%
% misc NONINSECTS	0%
Baetidae/EPHEMEROPTERA	85%
Hydropsychinae/TRICH	0%

APPENDIX B. Biotic index tolerance values (0-10) for aquatic macroinvertebrates commonly encountered in Montana.

PLECOPTERA

Capniidae 1, Chloroperlidae 1, Luectridae 0, Peltoperlidae 0

Nemouridae 2

Amphinemoura banksi 2, Malenka spp. 1, Podmosta spp. 2, Prostoia besametsa 3, Soyedina pooteri 0, Visoka catarctae 0, Zapada spp. 2 (Z. cinctipes 3, Z. columbiana 2, Z. haysi 2, Z. frigida 1)

Perlidae 2

Acroneuria abnormis 2, Calineuria californica 2, Claassenia sabulosa 3, Doroneuria theodora 0, Hesperoperla pacifica 1

Perlodidae 2

Cascadoperla trictura 2, Cultus spp. 2, Isogenoides elongatus 3, Kogotus spp. 1, Megarcys spp. 1, Perlinodes aurea 1, Setvenia bradleyi 0, Skwala spp. 3 (S. curvata 2), Isoperla spp. 2, (I. fulva 3, I. fusca 0, I. longiseta 3, I. mormona 2, I. petersoni 1, I. pinta 2, I. sobria 2, I. quinquepunctata 2)

Pteronarcyidae 2

Pteronarcella badia 3, Pteronarcys californica 2

Taeniopterygidae 2

Doddsi occidentalis 2, Taenionema spp. 2, (T. pacificum 3)

EPHEMEROPTERA

Caenidae 7, Polymitarcyidae 2, Tricorythidae 4

Baetidae 4

Baetis bicaudatus 2, B. hageni 5, B. propinquis 6, B. insignificans 4, B. tricaudatus 4 Callibaetis spp. 9, Pseudocloeon edmundsi 6

Ephemeridae 4

Ephemera simulans 1, Hexagenia limbata 6

Ephemerellidae 1

Attenella margarita 3, Caudatella spp. 0, Drunella coloradensis 0, D. doddsi 1, D. flavilinea 2, D. grandis 2, D. spinifera 0, Ephemerella inermis/infrequens 4, E. alleni 1, Seratella mitchneri 0, S. tibialis 2, Timpanoga hecuba 2

Heptageniidae 4

Cinygma spp. 0, Cinygmula spp. 0, Epeorus albertae 2, E. deceptivus 0, E. grandis 0, E. longimanus 1. Heptagenia elegantula 4, H. solitaria 3, Ironodes spp. 0, Nixe criddlei 2, N. simplicoides 4, Rhithrogena spp. 0, Stenonema terminatum 4

Leptophlebiidae 2

Choroterpes albiannulata 2, Paraleptophlebia spp. 1 (P. bicornuta 2), Traverella albertana 2

Siphlonuridae 1

Ameletus spp. 0, Siphlonurus spp. 2

TRICHOPTERA

Helicopsychidae 3, Lepidostomatidae 1, Molannidae 6, Phryganeidae 4, Psychomyiidae 2

Brachycentridae 1

Amiocentrus aspilus 3, Brachycentrus americanus 1, B. occidentalis 2, Micrasema bactro 1

Glossosomatidae 0

Agapetus spp. 0, Anagapetus spp. 0, Culoptila sp. 1,Glossosoma spp. 0, Protoptila spp. 1

Hydropsychidae 4

Arctopsyche grandis 2, Cheumatopsyche spp. 5, Hydropsyche bidens 3, H. occidentalis 5, H. placoda 3, H. seperata 4, H. simulans 7, H (Ceratopsyche) bronta 5, H. (C.) cockerelli 4, H. (C.) morosa 6, H. (C.) oslari 3, H. (C.) slossonae 4, H. (C.) tana 3, H. (C.) vexa 3, Parapsyche spp. 0

Hydroptilidae 4

Agraylea spp. 8, Hydroptila spp. 6, Leucotrichia pictipes 2, Ochrotrichia spp. 4, Zumatrichia notosa 3

Leptoceridae 4

Ceraclea spp. 3, Mystacides spp. 4, Nectopsyche spp. 3, Oecetis spp. 8

APPENDIX B. Biotic index tolerance values (0-10) for aquatic macroinvertebrates commonly encountered in Montana.

Limnephilidae 3
Apatania spp. 3, Chyranda centralis 2, Cryptochia furcata 1, Dicosmoecus spp. 2, Ecclisomyia spp. 4, Glyphopsyche irrorata 1, Hesperophylax spp. 3, Homophylax spp. 2, Limnephilus spp. 3, Neophylax spp. 3, Neothremma spp. 1, Oligophlebodes spp. 3, Onocosmoecus spp. 3, Psychoglypha spp. 0,
Philopotamidae 3
Chimarra utahensis 4, Dolophilodes spp. 0, Wormaldia gabriella 0
Polycentropodidae 6
Neureclipsis spp. 7, Nyctiophylax spp. 5, Polycentropus spp. 6
Rhyacophilidae 0
Rhyacophila brunnea (group) 2, R. spp (all others) 0

COLEOPTERA
Dryopidae 5
Elmidae 4
Cleptelmis ornata 4, Dubiraphia spp. 6, Heterlimnius corpulentus 3, Lara avara 1, Microcylloepus pusillus 5, Narpus concolor 2, Optioservus spp. 4, Stenelmis oregonensis 5, Zaitzevia parvula 4

LEPIDOPTERA
Pyralidae 5

MEGALOPTERA
Sialidae 4

ODONATA
Aeshnidae 5, Libellulidae 9, Lestidae 9
Gomphidae
Ophiogomphus servus 5
Coenagrionidae 9
Argia spp. 7

DIPTERA
Athericidae 2, Blephariceridae 0, Chaoboridae 8, Dueterophlebiidae 0, Dixidae 4, Dolochopodidae 4, Ephydridae 6, Pelecorhynchidae 1, Psychodidae (Pericoma spp.) 4, Stratiomyidae 7, Tabanidae 6, Tanyderidae 5
Ceratopogonidae 6
Culicoides spp. 10, Ceratopogoninae 6
Chironomidae
Chironominae 8
Chironomus spp. 10, Cryptochironomus spp. 8, Cryptotendipes spp. 6, Demicryptochironomus spp. 8, , Dicrotendipes spp. 8, Glyptotendipes spp. 10, Microtendipes spp. 6, Parachironomus spp. 10, Paracladopelma spp. 7, Paratendipes spp. 10, Phaenopsectra spp. 7, Polypedilum spp. 6, Pseudochironomus spp. 5, Robackia spp. 4, Stenochironomus spp. 5, Stictochironomus spp. 9, Xenochironomus spp. 4
Tanytarsini 6
Cladotanytarsus spp. 7, Micropsectra spp. 4, Rheotanytarsus 6, Paratanytarsus spp. 6, Stempellina spp. 2, Stempelliniella spp. 4, Tanytarsus spp. 6
Tanypodiinae 7
Ablabesmyia spp. 8, Apsectrotanypus 8, Brundiniella spp. 3, Larsia spp. 6, Macropelopia spp. 6, Natarsia spp. 8, Pentaneuria spp. 6, Procladius spp. 9, Psectrotanypus spp. 10, Tanypus spp. 10, Thienemannimyia (group) 5, Zavrelimyia spp. 8

APPENDIX B. Biotic index tolerance values (0-10) for aquatic macroinvertebrates commonly encountered in Montana.

Diamesinae 5
Diamesa spp. 5, Pagastia spp. 1, Potthastia spp. 2, Psuedodiamesa spp. 2, Sympotthastia spp. 2
Prodiamesinae
Monodiamesa spp. 7, Odontomesa spp. 4, Prodiamesa spp. 3
Podonominae 1
Boreochlus spp. 1, Parochlus sp.1
Orthocladiinae 6
Brillia spp. 4, Cardiocladius spp. 5, Corynoneura spp. 7, Cricotopus spp. 7, Diplocladius spp. 5, Eukiefferiella spp. 8, Krenosmittia spp. 1, Heterotrissocladius spp. 0, Hydrobaenus spp. 8, Lopescladius spp. 2, Nanocladius spp. 3, Orthocladius spp. 6, Paracladius spp. 8, Parakiefferiella spp. 6, Parametriocnemus spp. 5, Paraphaenocladius spp. 4, Psectrocladius spp. 8, Pseudorthocladius spp. 0, Pseudosmittia spp. 6, Rheocricotopus spp. 4, Symposiocladius spp. 2, Synorthocladius spp. 2, Thienemanniella spp. 6, Tvetenia spp. 5
Empididae 6
Chelifera spp. 5, Hemerodromia spp. 6, Oreogeton spp. 4
Simuliidae 6
Cnephia spp. 1, Prosimulium spp. 4, Simulium (Eusimulium) spp. 5, S. (Psilozia) spp. 7, Twinnia spp. 7
Tipulidae 3
Antocha spp. 3, Dicranota spp. 3, Erioptera spp. 7, Hesperoconopa spp. 1, Hexatoma spp. 2, Limnophila spp. 3, Pedicia spp. 6, Pilaria spp. 7, Pseudolimnophila spp. 2, Rhabdomastix spp. 1, Tipula spp. 4

ANNELIDAE
Oligochaeta
Enchytraedae 4, Lumbricidae 4, Lumbriculidae 4, Naididae 8, Tubificidae 10
Hirudinea
Erpobdellidae 8, Glossiphoniidae 9, (Helobdella stagnalis 10)

CRUSTACEA
Decapoda 6, Isopoda 8
Amphipoda
Gammerus spp. 4, Hyallela azteca 8

MOLLUSCA
Ferrissia spp. 6, Gyraulus spp. 8, Helisoma spp. 6, Lymnaedidae 6, Physidae 8, Sphaeriidae 6
TURBELLARIA 4